

AERO DIGEST

INCLUDING
AVIATION ENGINEERING

NOVEMBER 1954

50 CENTS

IN THIS ISSUE

BOEING'S 1000th B-47

WATER TUNNEL: TOOL IN AERODYNAMIC RESEARCH

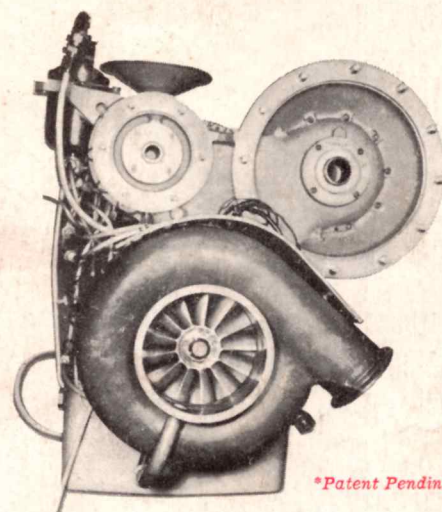
LOCKHEED F-94C CUTAWAY

"Twin Turbine Teamwork"

-a New Principle

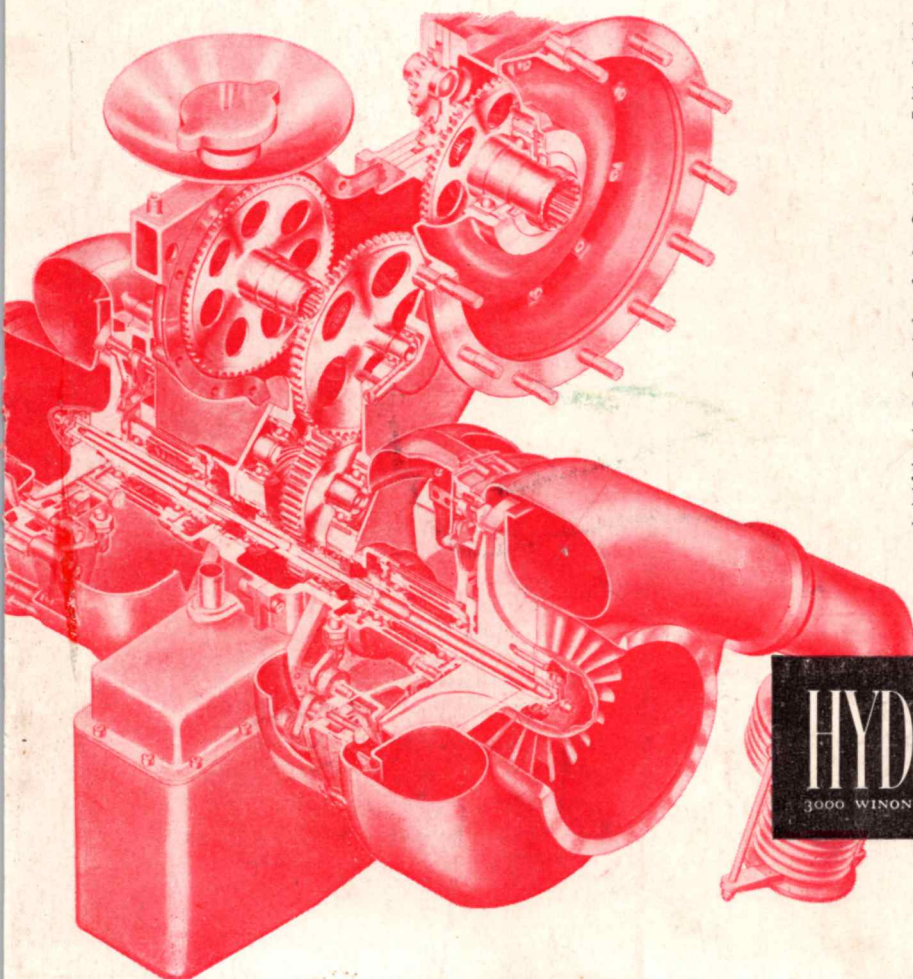
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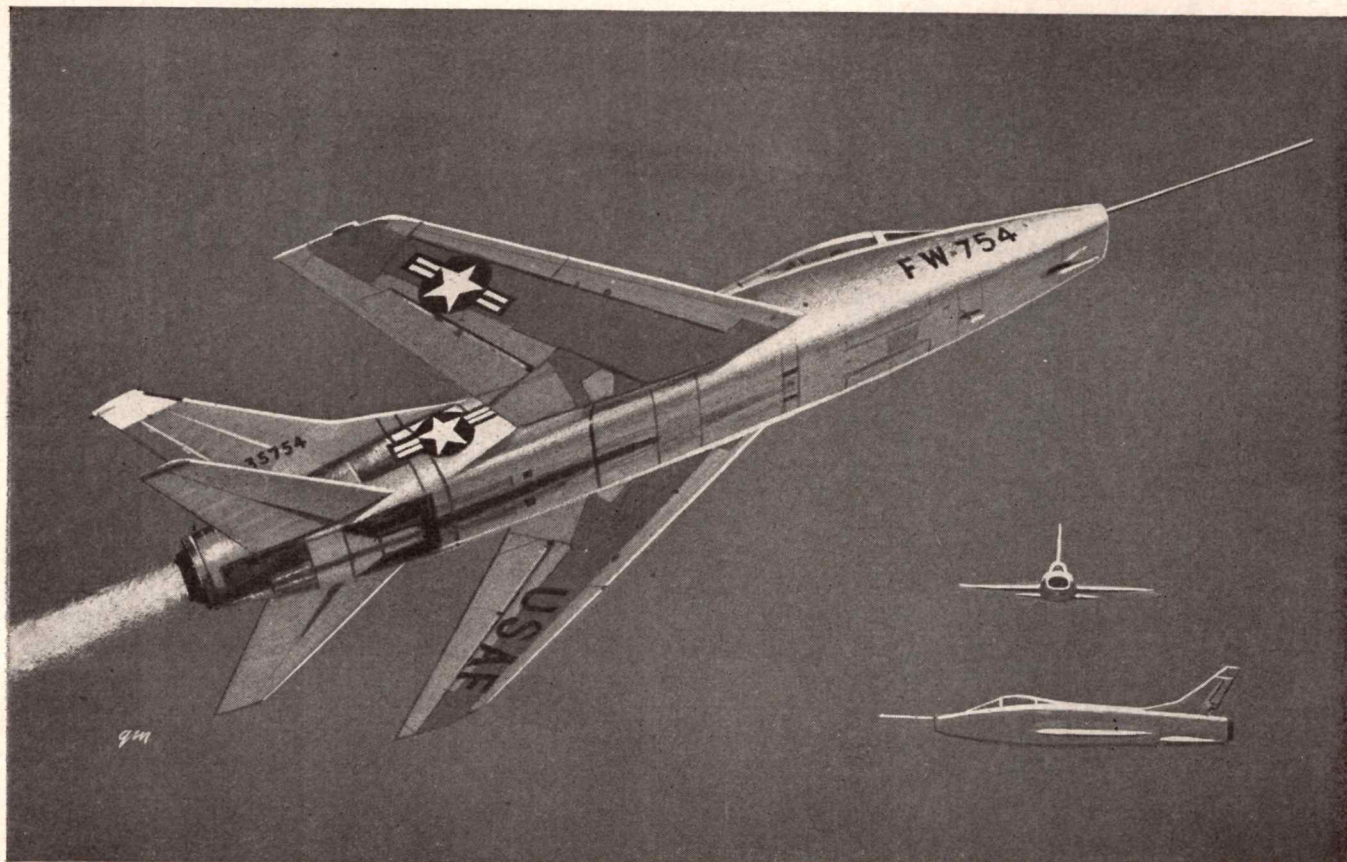
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See page 14 for acknowledgments



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AERO NEWS DIGEST

IN LIGHT OF WHAT is going on at the Pentagon, we have been expecting something of the sort to appear these many months—a Small Defense Industries Association, devoted to presenting and defending the case of small business in the defense effort. From Glendale, Calif., comes word now that such a group has been organized. SDIA representatives have already presented their case to the Pentagon, where no less than Roger Lewis, Assistant Secretary of the Air Force for Materiel, assured them that he was “aware of the distress prevailing” among the small subcontractors and was “working with representatives of the major prime aircraft contractors in an attempt to improve the situation.” The Washington meeting was followed by a press conference in Los Angeles, where Hampden Wentworth, President of Longren Aircraft as well as of the SDIA, reported that an overwhelming majority of small producers have suffered severe setbacks or look forward to a bleak future or both. How these facts can be reconciled with Mr. Lewis’ assurances is one of the things that we hope the SDIA finds out.

THE WEST COAST group are neither negative nor embittered in their approach to the problem. “We do not ask for coddling or hand-holding,” says W. W. Kratz, now President of Electronic Products Co., of Santa Barbara. “All we want is a competitive chance.” To get it, he proposes a coordinating committee of military, Federal and civilian groups concerned with procurement. Job of the committee will be to find ways of using small plant potentials “to the maximum extent.” Reporting on the Pentagon meeting, George Wing, President of Hi-Shear Rivet Tool Company, was careful not to blame the larger aircraft manufacturing units for the current troubles. They are not, he pointed out, being given profitable enough incentives to deal with smaller firms. Indeed, today they are penalized profit-wise for dealing with subcontractors. “Smaller contrac-

tors,” he reports, “are able to produce parts more economically, but the government is allowing primes less profit on subcontracted items.” The current Pentagon explanation of this is economy. Mr. Wing points out in rebuttal that a depression among the subcontractors will result in highly skilled persons in the field going to other jobs. They will not be available for an emergency and in the meantime “the national preparedness effort will suffer irreparable damage.”

THE SDIA CASE is not new: it has been a standard problem since peace-time defense production became national policy. It may also be assumed that the SDIA membership, already totalling 50 member companies and growing, will find many friends in the aircraft industry to support them. But to seek real and sustained Pentagon support is something else again. Pentagon policy is today toward bigger and bigger contracts to larger and larger corporations. The only way that policy can be changed is by a concerted and sustained effort and a realization that happy-talk around a Pentagon conference table is difficult, if not impossible, to convert into orders. The SDIA is going to have a fight on its

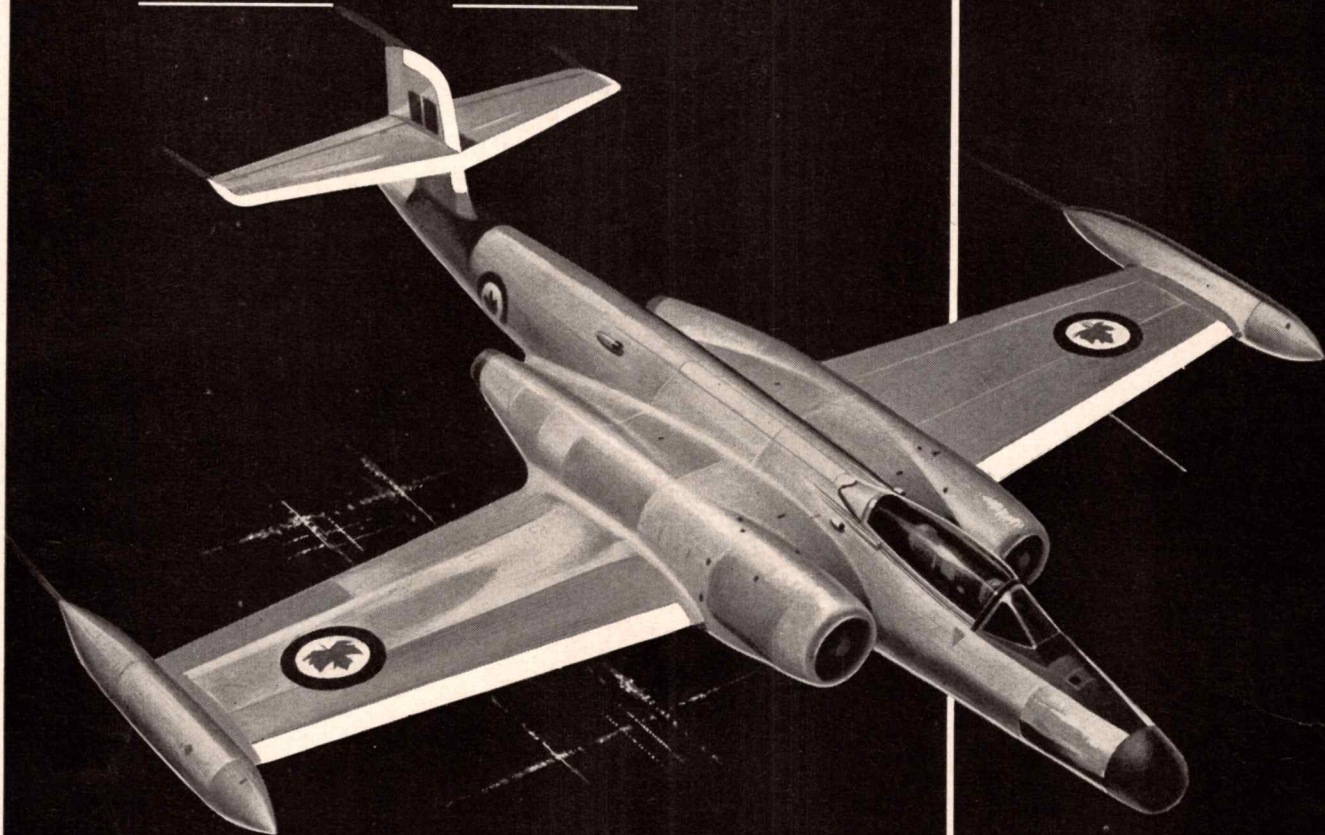
hands to get anything but token recognition of what the organization desires. Meantime, it appears to be strong, well-led, and eager to get its story across in the interests of the defense effort. Its members can already see a depression on the horizon if major changes are not made, and they propose to do something about it before it is too late.

PROCUREMENT NEWS broke big during October with the announcement of details of Air Force purchasing plans during the fiscal year ending next July. Stars of the release from Air Force Secretary Harold E. Talbott were the Convair B-58 supersonic bomber and the Lockheed F-104 lightweight supersonic air superiority fighter. Both have been ordered into initial production. Orders have also been increased and stepped up on both Boeing B-52s and North American F-100s. Total orders placed by the Air Force since July 1 are more than \$1.2-billion, Secretary Talbott added. Production orders on the B-58 and the F-104 bring the total new types of planes introduced into the current program to three. The first was the Boeing KC-135 jet tanker (the Boeing 717), announced previously. The B-58

L. to R. General W. W. Kratz (Electronic Products Corp.) Hampden Wentworth (Longren Aircraft) and George Wing (Hi-Shear Rivet Tool Co.) as they appeared at press conference of Small Defense Industries Association Oct. 12



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will be built by Convair at Ft. Worth. B-52's will come from Seattle and from increased output at Wichita. The F-104 will be built at Lockheed's Burbank, Calif., plant.

DESPITE THE TANKER status of the Boeing 717 in Air Force circles, its creators still contend that its transport version, the jet 707, is the real McCoy. Latest to testify in its behalf is M. L. Pennell, Chief Project Engineer for the plane. "We convinced ourselves," he says, "that improvements in economy were achievable goals for a jet transport. Today, we are more than ever convinced that our conclusions were correct. Let's look at the economics of a jet. Can it compete with the best of today's airplanes? The answer in our opinion is emphatically, 'Yes!' The predicted operating cost of the 707 is below ten cents per ton mile, compared with commonly accepted operating costs of thirteen to fifteen cents for the most economical of the present-day transports."

HOW CAN THE 707 PAY OFF economically "The answer," says Mr. Pennell, "is in the work capacity of the plane. It can carry more payload, at more miles per hour. Work capacity in ton-knots (the product of payload times block speed in knots) is three to four times that of current transports—twice the payload delivered at twice the speed. Thus the higher cost per hour is more than offset by the far greater earning capacity." He also reports that the fuel costs are moderate by today's standards and "other costs are consistently less than those of today's planes except for engine maintenance, which includes spares and overhaul on a very conservative basis."

"GET YOUR SLIPSTICK and see for yourself what technical and operating advantages" would occur if

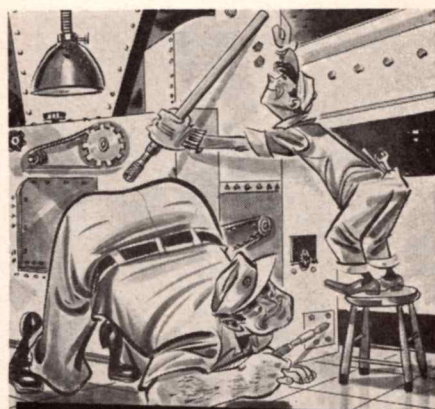
Another entry into the light twin-engine field is this Monocoupe Meteor. It is four-place with 150 hp Lycoming engines and full-feathering props. Certification tests are now underway. Expected cost—\$25,000



a dirigible were built with all available modern materials and ideas. Thus advises that lighter-than-air enthusiast, retired Vice Admiral Charles E. Rosendahl. Undismayed by lack of Navy interest in rigid lighter-than-airs and still enthusiastically convinced that when Harold Ickes denied helium to the Germans he wrecked this nation's dirigible opportunities, the Admiral believes we are overlooking the possibilities in this area, and Congress should look into it thoroughly and put up some money for buoyant air transport. He sees a "really modern airship, designed from scratch," surpassing anything of its kind in the past and rivalling planes of the future as an economic unit of transport. Helium would, of course, make the big job immeasurably safer. The hull could be built of titanium, "opening up vast horizons." He sees boundary layer control reducing external drag to less than 10 percent and a 20 percent overall drag reduction, adding up to a five-times increase in range or an increase of 1.7 times in speed with the same engine power.

EVEN MORE IMPRESSIVE to Admiral Rosendahl are the possibilities in nuclear power. Gordon Dean, former Atomic Energy Commission Chairman, says that "one place where the atomic engine can come into its own is in the now all-but-forgotten dirigible." This Rosendahl approves with enthusiasm and goes on to envision a "conservative" 10-million cu. ft. airship with a cargo volume capacity of at least 70,000 cu. ft.—"as much as 20 to 25 average box-cars." "In the public interest," he concludes, "Congress should be urged to set up a joint committee to resolve the unfortunate airship picture. A carefully considered, comprehensive plan" should follow, with emphasis on "commercial ships for international commerce."

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- ★ Trans Canada
- ★ Transportes Aereos Portugueses
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- ★ Western
- ★ West Coast Airlines



First of the Martin P5M-2 Marlin is now in service with patrol squadron VP-47

the flying machine, especially in its jet versions, has been making a lot of bad news for itself during recent months. The neighbors think it's too noisy. Airport management, conscious of the truth of this conclusion so far as a layman living next door is concerned, are extending public relations to the operational level to offset complaints. Runway patterns have been changed to take planes off and land them away from community areas. Meetings have been held explaining the problem to local citizens. A long-overdue community-relations campaign has been launched by local Air Force commands, finally awakened from a public-be-damned attitude by public opposition. It's understandable when you analyze a few facts. The sound produced by a jet engine is in the order of 70,000 watts of sound power—about 1/1000th of the decibals turned loose by a 75-piece orchestra in full cry. And this is just a mine-run jet engine we're talk-

ing about—tomorrow's really big ones will be noisier by far.

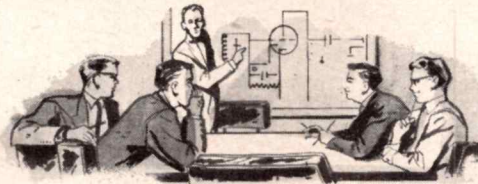
WHAT TO DO? Operators, military or otherwise, cannot shield the noise, as many an engine and plane manufacturer has done with his test laboratories and stands. And although the experts are extending themselves in all directions to allay the resulting troubles, it would seem that the problem is going to be with us—and aggravated—as time goes by. No less an authority than Brigadier General Marvin C. Demler, Assistant Deputy Commander, Technical Operations, Air Research and Development Command, sees nothing but trouble ahead. "Our major noise sources will be significantly increased within the foreseeable future," he reports. Change in flight procedures and community education are the only antidotes.

TYPICAL OF THE MAGNIFICENT—and costly—job the industry is doing to abate noise is a jet test cell about to go into action at Ryan Aeronautical Company, San Diego. The facility will test jet engines and afterburners. Muffling equipment cost \$50,000 and will cut the roar of the engine in half. This means in fact that noise heard outside the jet test cell will be only 1/100th the amount created by an unmuffled jet. Employees outside the test cell will actually be able to talk in normal tones. The Ryan unit was designed and built by Industrial Sound Control, Inc., of Hartford, Conn. Sound is trapped and absorbed in maze-like

Interior mockup of Martin B57-B, proposed V.I.P. transport



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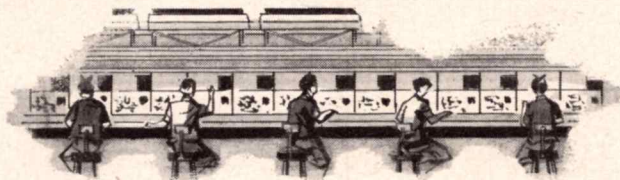
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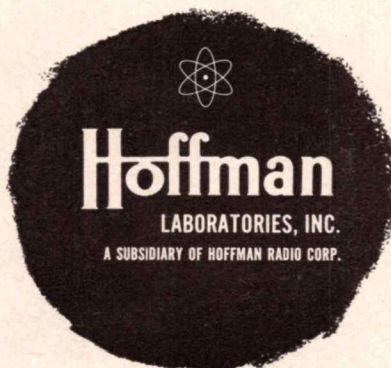
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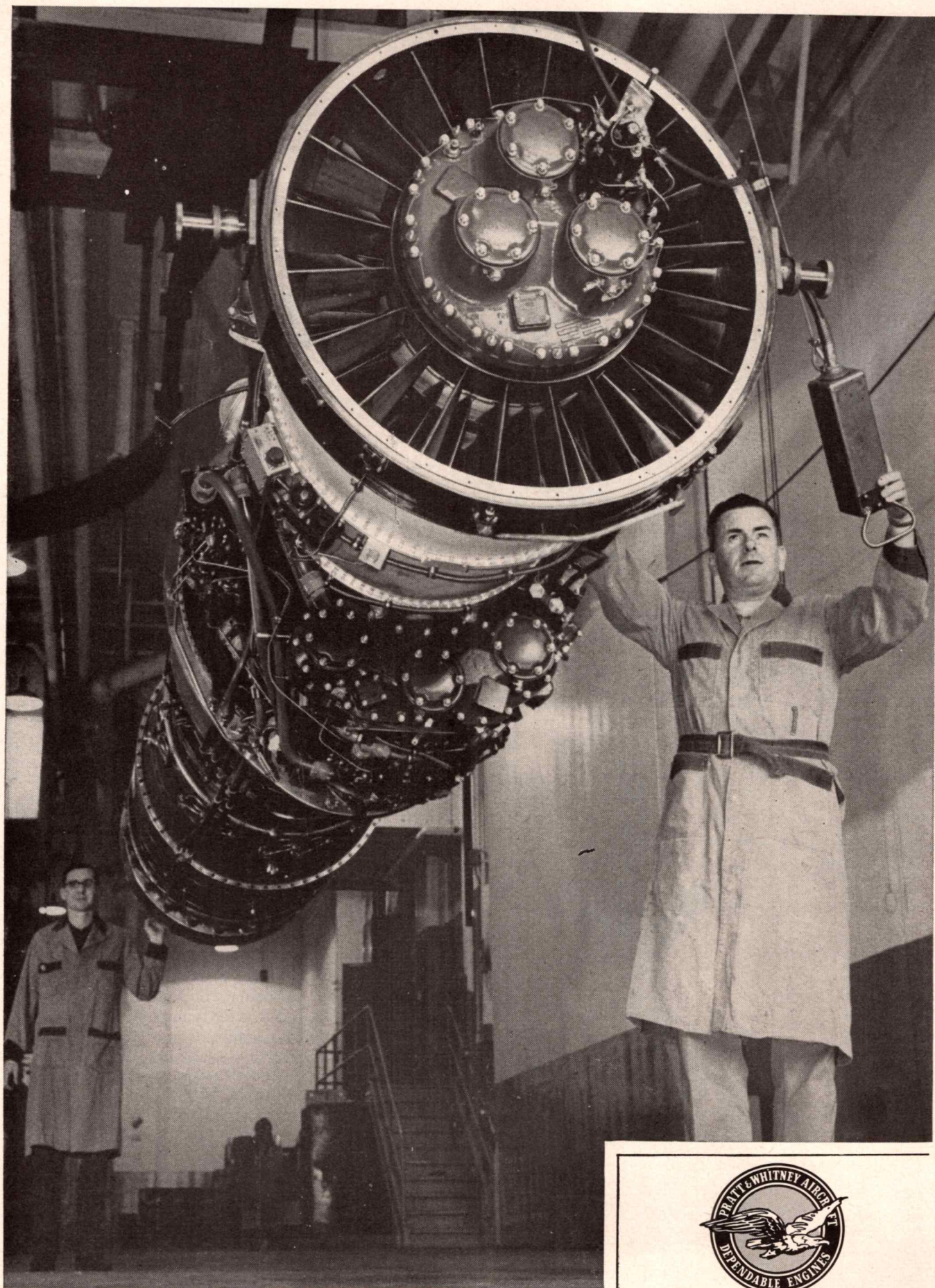
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Sharply swept-back wings and tail surfaces mark the North American F-100 Super Sabre. Built around one Pratt & Whitney Aircraft J-57 turbojet and afterburner, the Super Sabre is the Air Force's first operational supersonic jet fighter.

Super Sabre Has Supersonic Performance

Sustained level flight above Mach 1 is a vital attribute of the latest U. S. fighting aircraft, and North American's F-100 Super Sabre has it.

Such hard-won capability—possessed by only a few production aircraft—is the product of highly advanced airframe design wedded to a flexible, efficient turbojet engine of enormous power.

The sleek Super Sabre is now being built in quantity for the U.S. Air Force. Equipped with the

Pratt & Whitney Aircraft J-57 turbojet and afterburner, it has already set the world's speed record of 755.149 miles per hour—an enviable beginning for a fighter on which so much depends.

In the Super Sabre, as well as in other supersonic fighters and high-speed jet bombers, performance of the Pratt & Whitney Aircraft J-57 turbojet is fully justifying the long years and intensive effort required for its development and production.

Pratt & Whitney Aircraft

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• • •
VTO • Vertical take-off airplanes are the forerunners of a whole new stable of high-speed military aircraft, and they'll be in service sooner than you think, believes Arthur N. Tifford, of the aeronautical engineering faculty at Ohio State University and a former industry aerodynamicist. "They are likely to replace most current military high-speed aircraft within five to ten years," he believes. He is credited with foreseeing the current VTO's being built by Lockheed and Convair as early as 1949. "VTO is not in itself an innovation," he points out, "but before it could be achieved, there had to be the realization that the new powerplant developments of the jet age made it practical."

• • •
HEAT BARRIER • Most optimistic word in some months concerning breaking the heat barrier comes this month from Spencer L. Shaw, Douglas Aircraft Company Design Specialist. Through improved metals and research he sees planes that will neither deform or creep at sustained speeds up to 3000 mph at sea level and 7000 mph at 185,000 ft. He states flatly that speeds far greater than the engine power available to present planes could be handled with materials now on hand. His thinking is based on the facts that a plane going through the atmosphere at 700 mph would experience an outside body heat of 1400 deg. F. Aluminum on present-day planes begins to fail at 200 deg., but Mr. Shaw points out that stainless steel and cobalt base alloys can take it to the 1400 deg.

mark. He is not entirely optimistic, of course. He sees many difficult and complex problems ahead and counts on further metal development to help solve them.

• • •
NOTES AND SIDELIGHTS • The Crosley Division of AVCO Manufacturing Company, Cincinnati, has been awarded a contract to build three units of Volscan (February 1954 AERO DIGEST), the new air traffic control system developed by the Air Force Cambridge Research Center of the Air Research and Development Command. First unit is expected to be ready for testing by September, 1955. Units can control several airport traffic patterns at a time, and is almost entirely automatic.

A money-saving, safety-tested repair service is now available from the Aircraft Division of Ledkote Products Co., New York, which completely rehabilitates worn joint assemblies used to connect engine ports with exhaust collector rings on DC-4 aircraft.

The role of turboprop and turbojet transports in air cargo and air logistics will be one of the major topics of discussion at the annual meeting of The American Society of Mechanical Engineers in New York, Nov. 29-Dec. 3.

Structural engineers at North American Aviation, Inc., are making extensive use of vacuum-held tension pads in place of the glue-adhered pad for proof-loading experimental aircraft. Loading of large test specimens show considerable savings in time and money, according to Chief Structures Engineer R. L. Schleicher. Vacuum-held pads can be attached

and removed quickly, and used repeatedly. The old glue-cement type required a curing time of 24 hours, and it took 15-30 minutes to remove them and clean the cement from the surface after tests.

A whirl tower to cut cost and time required for testing parachutes, mainly those for high-speed jet bail-outs, is in full operation under Air-Force-Navy auspices at El Centro, Calif. The tower, developed by the Pioneer Parachute Company, Manchester, Conn., is electrically powered by General Electric equipment.

Production of the Pratt & Whitney J-48 turbojet engine which powers carrier-based fighter planes has been extended by the Navy. The big Turbo-Wasp powers Navy's Grumman F9F-5, F9F-6 and F9F-8 fighters. With an afterburner, it powers the Air Force Lockheed Starfire F-94C interceptor.

Additional production of Sky-sweeper anti-aircraft cannon, Army's companion weapon to the Nike for defense against low-flying attack beneath guided missiles, has been ordered from Sperry Gyroscope Company. Sky-sweeper is a three-in-one weapon, equally effective against medium- and low-level planes, and tanks.

Lear, Inc., announces a \$3-million Air Force contract for MB-2 autopilots. They will go into Republic F-84F Thunderstreaks. New-type, high-gain servo amplifiers in the MB-2 produce split-second, minutely accurate control responses, and a cross-feeding system for yaw and roll signals automatically coordinates rudder and ailerons at all times.

Lightplanes aircraft manufacturers are edging into the jet field via the military. Latest move is Cessna's first jet and the Air Force's newest trainer. A twin-jet, it is designated the XT-37. Its purpose is to introduce jet flying earlier in pilot training, thus saving money and time. The XT-37 made its first flight successfully early last month.

Northrop's Scorpion F-89 all-weather-interceptors are being used to test a new type of fighter armament — the T-110 rocket launcher, an air-to-air weapon.

FRED HAMLIN

Latest in the jet trainer field is this XT-37 designed to introduce the pilot to jet aircraft earlier in the training cycle



Name any type of modern wing



sweepback ...



delta ...



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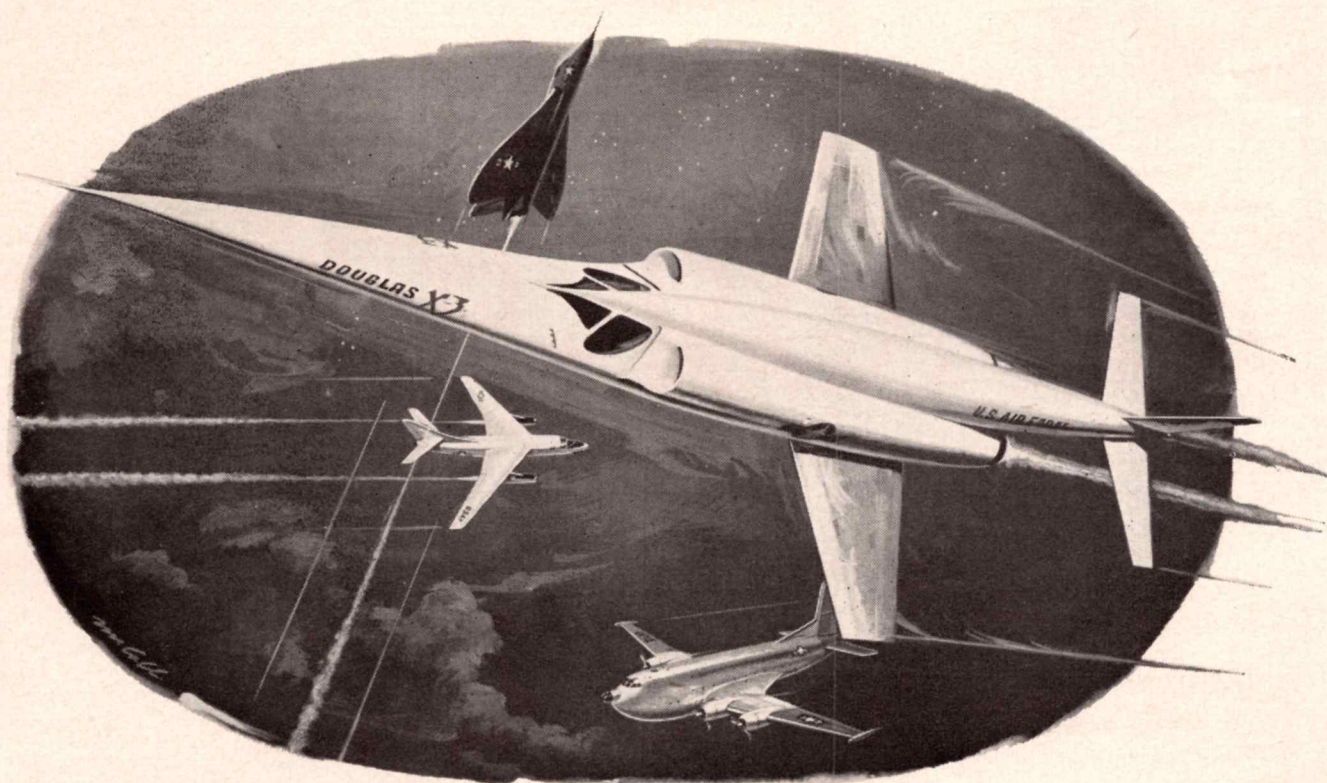
What is the ideal wing planform? Obviously, there can be no all-inclusive answer, for wings—like power plant or size—are designed to meet certain specific tactical requirements.

Thus a sweptback modified delta lets the Douglas F4D Skyray, first carrier plane to hold the official world speed

record, come in *slow* for carrier landings. The broad conventional wings of a Douglas C-118A Liftmaster contribute to the range and lift a cargo carrier needs—while the Navy's carrier-based A3D Skywarrior bomber flies at near-sonic speed on sleek, tapering, sweptback wings. Again, the experimental stilto-

shaped Douglas X-3—though bigger than a DC-3 transport—has a wingspan smaller than a DC-3's tail.

Correct design of airframes to meet intended use contributes to Douglas aviation leadership. Building planes to fly farther and faster with a bigger payload is a basic Douglas concept.



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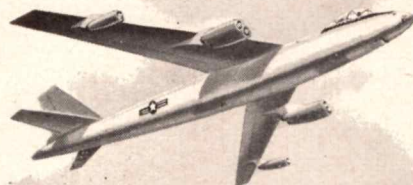
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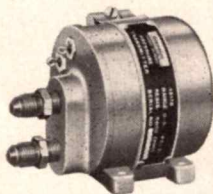
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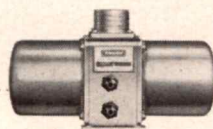
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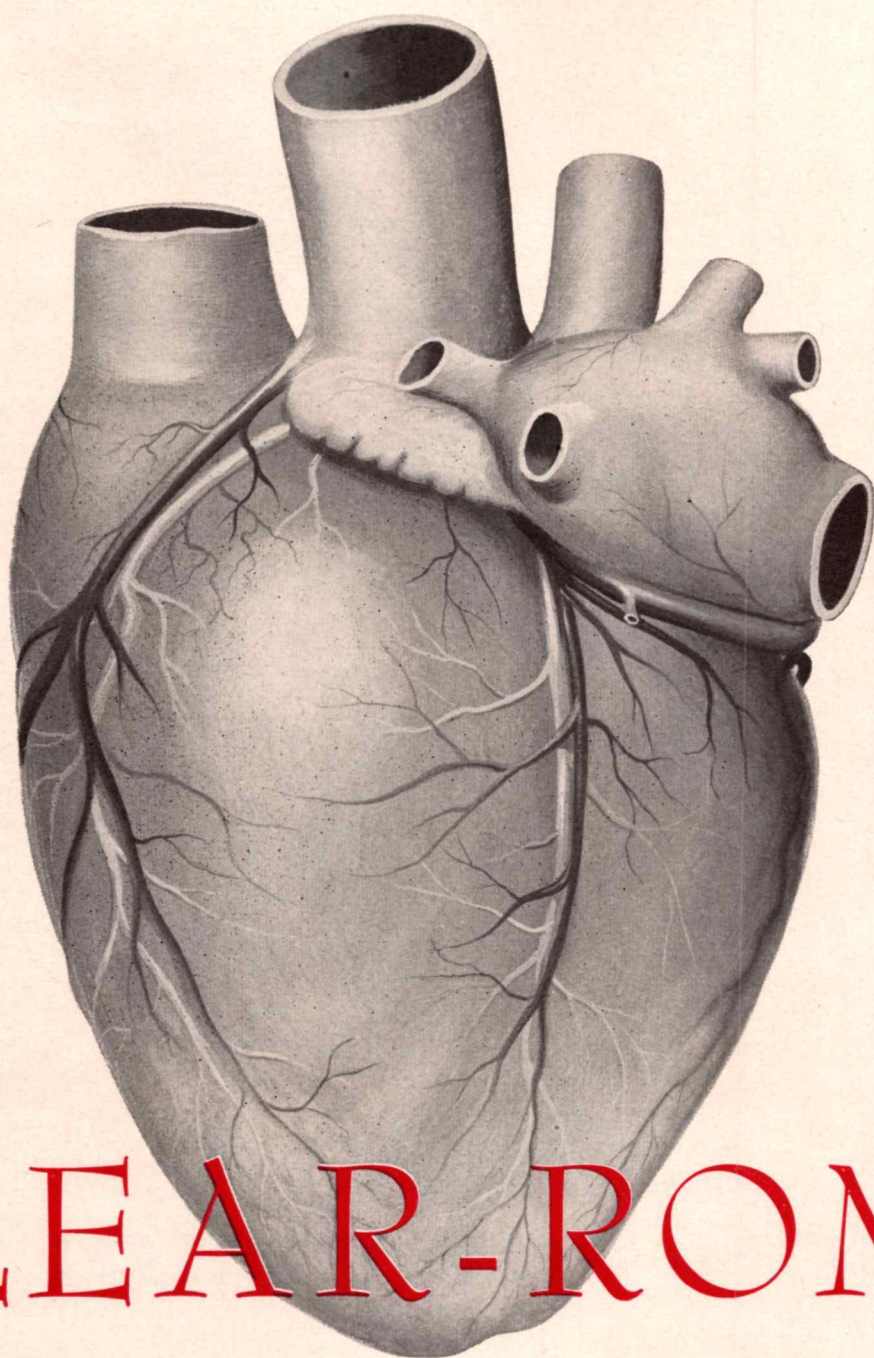


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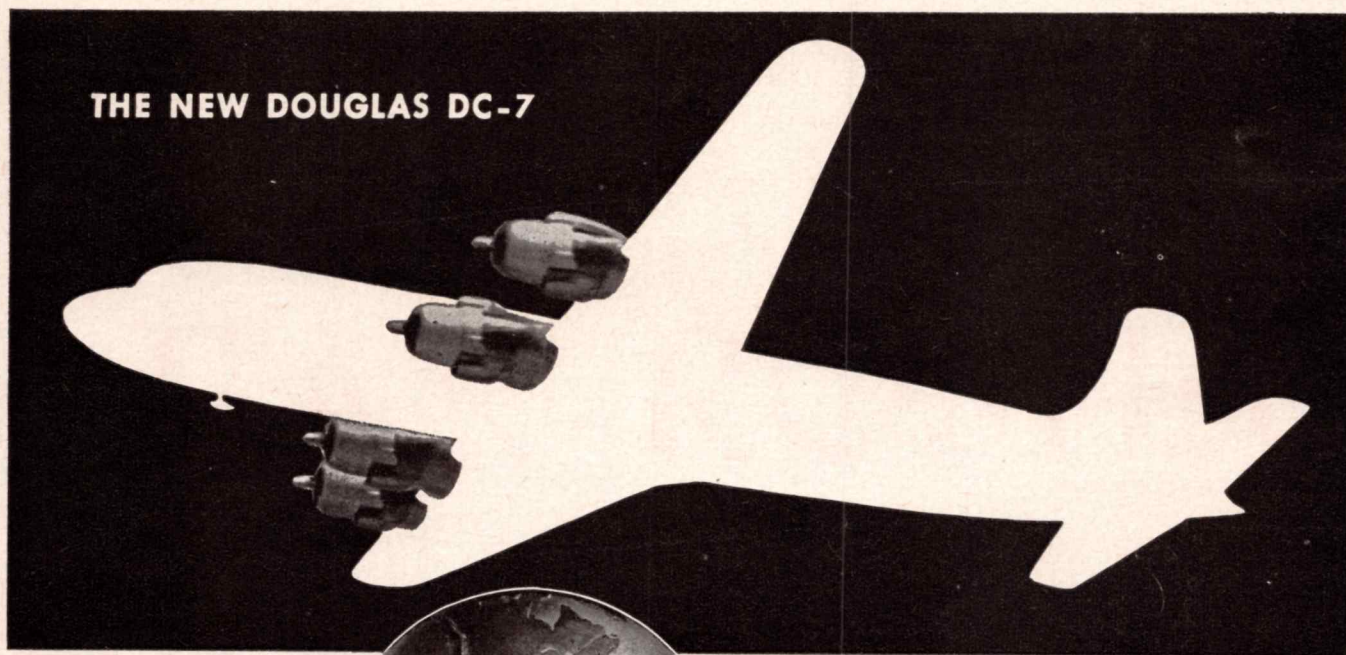
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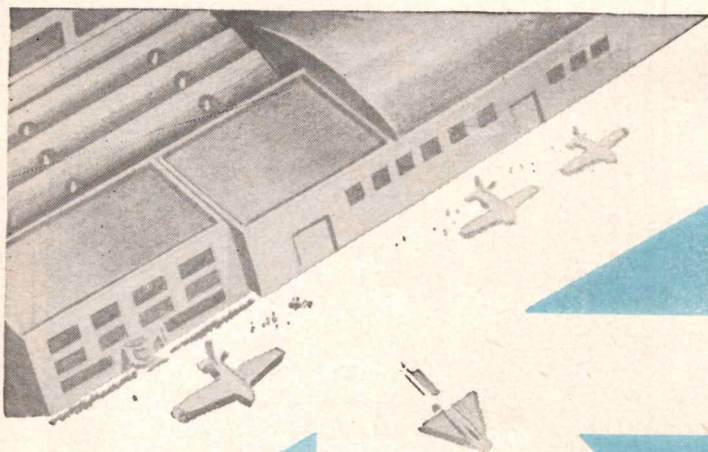


The silent world beyond sound is the scene of battle for the Navy Tiger. Grumman's new fighter slips through the "sonic barrier" as if air at the speed of sound were smooth instead of strange. Supersonic, she can make the fastest bombers prey for her missiles, or she can make an inland city the target of Navy attack carriers. Designed also for speed of production, the Tiger was built and flown in 15 months. Tigers for carrier operations will soon be in production.



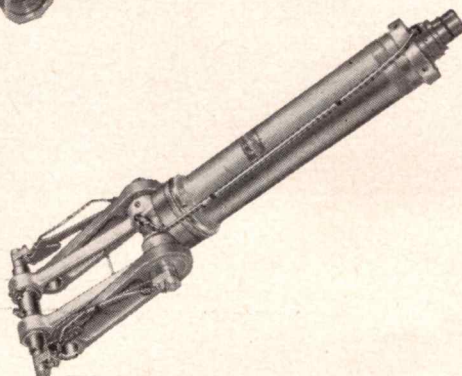
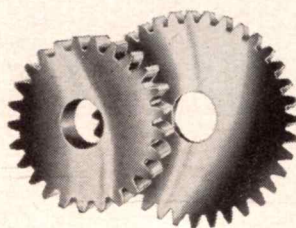
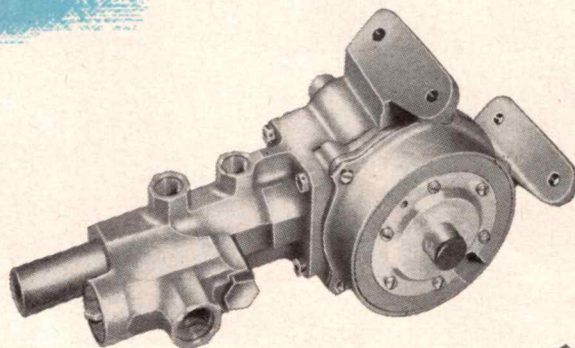
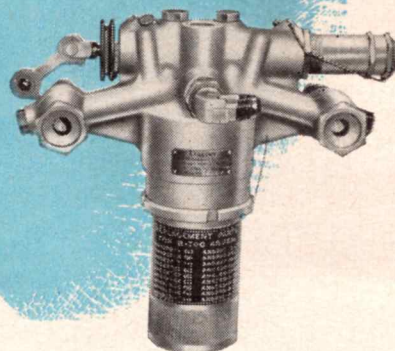
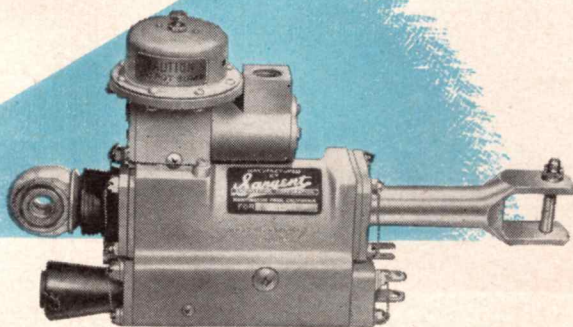
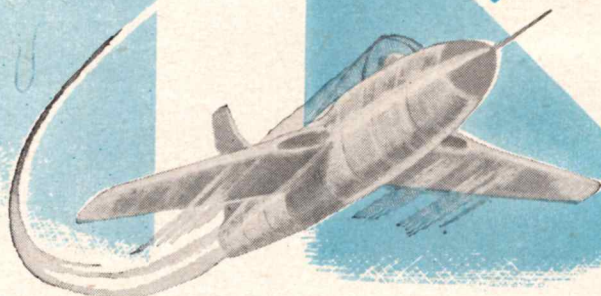
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"Good will" is the disposition of the pleased customer
to return to the place where he has been well treated.
— U.S. Supreme Court

Names in the News

Four new editors for Aero Digest are named

Dr. Antonio Ferri, who becomes the new Technical Editor, is a Professor of Aerodynamics at Brooklyn Polytechnic Institute, Brooklyn, N. Y. He is internationally known as a scientist in aviation, a member of the Subcommittee for Fluid Dynamics for the National Advisory Committee for Aeronautics, and a consultant to both the Air Force Air Research and Development Command and for the Advisory Group for Aeronautical Research and Development, NATO.

He holds two doctor's degrees, both from the School of Engineering, University of Rome, where he was graduated in 1929 at the age of 17. He received his doctor's in Electrical Engineering in 1934 and in Aeronautical Engineering in 1936. In 1935, he was assigned to the Direzione Superiore Studi

Esperienze of the Italian Air Ministry and in 1937 became head of the Supersonic Wind Tunnel at Guidonia, Italy — the first wind tunnel to go into operation and, until 1942, the largest. In 1940, he became head of the Aerodynamics Branch of the Direzione as well as an Associate Professor at the University of Rome.

In 1943, following German occupation of Italy, Dr. Ferri joined the Italian underground as head of the Partisan Brigade Spartaco.

He came to the United States on a secret mission for the Offices of Strategic Services in 1944. In 1946, he got a permanent passport and was joined by his family. Later, he was appointed head of the aerodynamics section of the National Advisory Committee for Aeronautics at Langley Field, Va., where he worked closely with John Stack, Collier's Trophy winner in 1952, the same year he became an American citizen.

New Managing Editor **William Beller** was formerly Assistant Director of Public Relations for the Ford Instrument Company, a Senior Stress Analyst for Consultants and Designs, Inc., New York, and a Senior Aerodynamicist for Hughes Aircraft Company, Culver City Calif. A resident of New York, he is moving to Washington, D. C., headquarters of Aero Digest, to take over his new post.

Mr. Beller holds a Bachelor of Science in Mechanical Engineering from Georgia Institute of Technology and a Masters of Aeronautical Engineering from the Guggenheim School of Aeronautics, New York University. He has contributed to Aero Digest, his latest article appearing in June, 1953, "Graphical Shear and Moment Calculation."

Third staff addition, who will become Military Editor for Aero Digest, is **William Frye**, for more

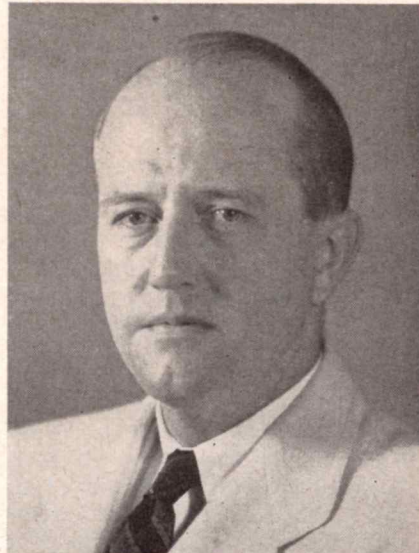


Dr. Antonio Ferri, Technical Editor

William Beller, Managing Editor



William Frye, Military Editor



than a decade with the Associated Press. During the last war he was in charge of AP War Department coverage and a war correspondent in the European Theater. He also served as Special Consultant to Secretary of War Patterson and Secretary of Defense Forrestal. As Director of Public Information, Office of the Secretary of Defense, he had charge of combining informational offices when the Defense Department was unified in 1949.

Samuel S. Oleesky joins *Aero Digest* as *Plastics Editor*. A Californian, he is Vice-President and Chief Scientist with *Micronics, Inc.*, at Gardena, and a nationally-known authority in the application of plastics to aerodynamics problems, particularly in the supersonic field.

• • •

Leaman L. Cox, has joined *Stanley Aviation Corp.*, Denver, Colo., as Assistant Plant Manager . . . For "attaining his eminence and distinction," **Water A. Spivak**, North American Aviation's Chief Project Engineer, was awarded the Outstanding Achievement Medal of the University of Minnesota's Department of Aeronautical Engineering.

Appointment of **Robert Insley** as Chief Product Engineer for the Aircraft Engine Division of Ford Motor Co., Chicago, is announced by **John Dykstra**, Vice President. Mr. Insley co-authored the book, "Aircraft Power Plants" . . . **Edwin J. Ducayet**, formerly Assistant to the Vice President, in charge of Bell Aircraft Corp.'s Helicopter Division, has been promoted to Assistant Manager of Bell's Texas Division.

At a dinner in New York, **L. L. Colbert**, President of the Chrysler Corp. presented bronze plaques to a group of prominent aeronautical engineers. In recognition of their outstanding contributions to the field of aeronautics, the manufacturers and engineers honored were: **Glenn L. Martin**, **Louis Bréguet** (France), **John K. Northrop**, **Lawrence Bell**, **William Piper**, **Michael Stroukoff**, **Edgar Schmued** (Northrop), **Geo. S. Trimble, Jr.** (Martin), **Michael E. Gluhareff** (Sikorsky), **Hall L. Hibbard** (Lockheed), **R. C. Sebold** (Convair), **Raymond H. Rice** (North American), **Alexander Kartveli** (Republic), **Walter Tydon** (Fairchild), and **Robert L. Hall** (Grumman). Assisting in arrangements



Glenn L. Martin (left) receives a plaque from L. L. Colbert in recognition of his outstanding aviation contributions. *AERO DIGEST*'S George McLaughlin is at right

for the ceremony were **Ansel Talbert**, Aviation Editor of the *N. Y. Herald Tribune*, and **George McLaughlin** of *Aero Digest*.

A new division of the engineering department of *TEMCO Aircraft Corp.*, Dallas, Tex., Systems Research and Development Division—will be headed by **William B. Freeman**, who came to TEMCO from Chance Vought Aircraft Inc. where he directed systems engineering on the *Regulus* . . . **J. L. Velazquez** has been named Chief Helicopter Engineer by *Weber Aircraft Corp.*, Burbank, Calif., to head developmental and experimental work on a new pulse jet prototype.

Formerly Assistant Chief Engineer with *Fenwal, Inc.*, Ashland, Mass., **Raymond H. Matthews** has been promoted to Chief Engineer . . . **Robert L. Earle** has been elected Executive Vice President of *Marquardt Aircraft Co.*, Van Nuys, Calif., to the board of directors, **Roy E. Marquardt**, President, announces . . . Also at Marquardt, **Robert F. Francis**, long-time employee, has been promoted to Manager of Production Engineering and Materiel.

C. D. Perrine, Jr., for many years prominent in the development of aircraft electronics and guided missiles, has been appointed Director of Engineering of the Pacific Division of *Bendix Aviation Corp.* . . . New manager of Allison's Dayton office is **K. J. Bigelow** . . . Aviation Sales Manager **Clarence I. Rice**, Bendix Radio Communications Division, Bendix Aviation Corp., announces the appointment of **Herschel A. Wolf**, formerly supervisor of aircraft radio for American Airlines, as Assistant Manager of Aviation Sales.

West Coast steel distribution executive, **Earle M. Jorgensen**, has

been elected to the board of directors of *Northrop Aircraft Inc.*, Hawthorne, Calif. . . . **Rear Adm. A. J. Wellings**, USN (Ret.), is now associated with *Harvey Machine Co., Inc.*, as technical consultant, announces **Leo M. Harvey**, President. Wellings, who served with the Navy for 35 years before retirement in July, earned the Legion of Merit for his work as Assistant Chief of Staff of Joint Task Force Seven when it carried out the historic first atom bomb tests at Eniwetok.

Three noted guided missile scientists have joined The new Guided Missile Research Division of *Ramo-Wooldridge Corp.*, Los Angeles affiliate of *Thompson Products, Inc.*: **Dr. Louis G. Dunn**, formerly Director of Jet Propulsion Laboratory, California Institute of Technology, where he was in charge of the Army's *Corporal* program, will be Associate Director; **Dr. Milton U. Clauser**, new Director of the Aeronautics and Structures Staff, was formerly head of *Purdue University's* School of Aeronautics, and **Dr. James C. Fletcher**, new Director of the Guidance and Control Staff, was formerly with *Hughes Aircraft Co.*, where he headed Theory and Analysis for the *Falcon*.

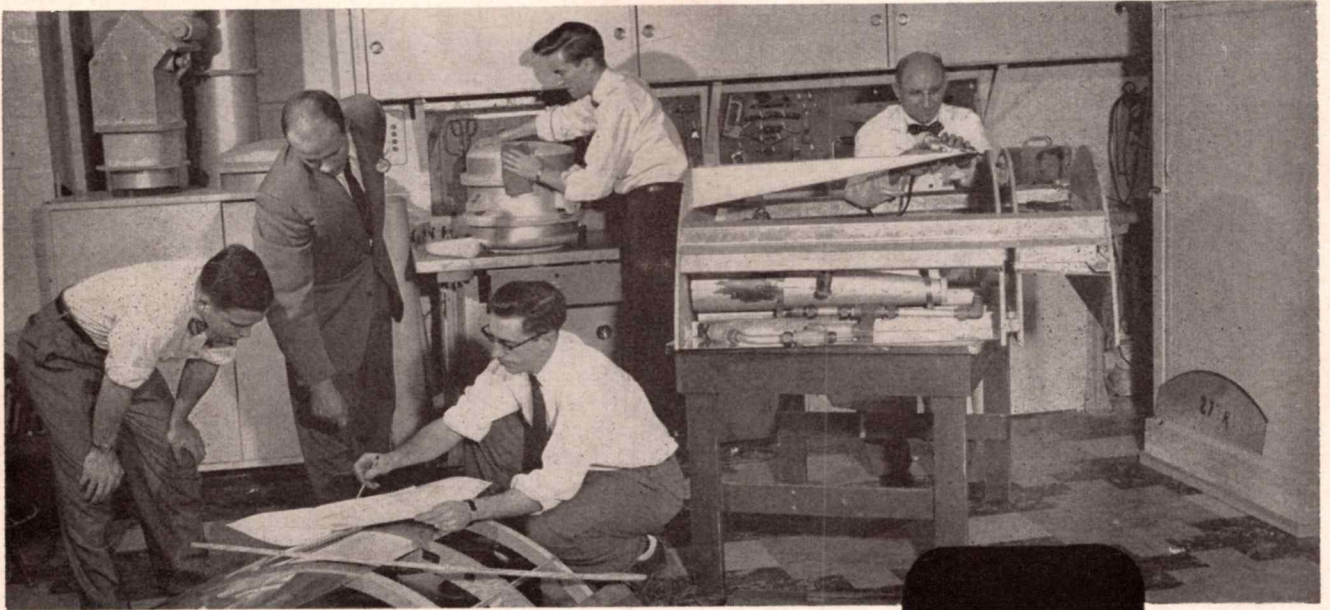


Leston P. Faneuf, new General Manager of Bell Aircraft

Bell Aircraft Corp., Buffalo, N. Y., had three changes in top management; **Lawrence D. Bell**, President and General Manager since the company's founding in 1935, has resigned as General Manager to devote full time to the Presidency; **Leston P. Faneuf**, former Assistant General Manager, was elected to succeed him as General Manager; **William A. Gisel**, Comptroller, was elected Secretary.

END

Fig. 1. Corner of 3-D layout shop. Industrial design techniques simplify production of aircraft models and broaden their utility at Martin Company



Martin Goes 3-D

By EDWARD GUARD

Supervisor, Three Dimensional Layout,
The Glenn L. Martin Company

**Highly-specialized Martin layout team uses new method
in solving engineering, styling and sales problems**

AIRCRAFT engineers have always placed a high valuation on models and mock-ups as visual aids in developing and promoting their ideas. But due to increasing pressures of competition, these days, the layout man often finds

himself faced by the problem of having to construct such models with marginal facilities or on fire-alarm schedules.

Some problems, of course, can still be solved by using bent-up paper clips—but when such factors

as complex tubing runs or interferences resulting from a compound curvature are involved, full-scale models are the only adequate answer. Perhaps he dare not compromise the deadline or the budget by rushing the construction of an elaborate mock-up. In that case, he must accept a considerable uncertainty in coming up with a two-dimensional layout—since he cannot be reasonably sure that it will resolve the complexity of the design.

The Martin Company has recognized this dilemma—and has done something about it. For some time now, the Engineering Division has been pioneering in the development of a highly specialized three-dimensional layout team—a group of engineers, industrial designers, shop technicians and liaison personnel who work in a security-isolated shop in the heart of the engineering division (Fig. 1). These men are selected for their

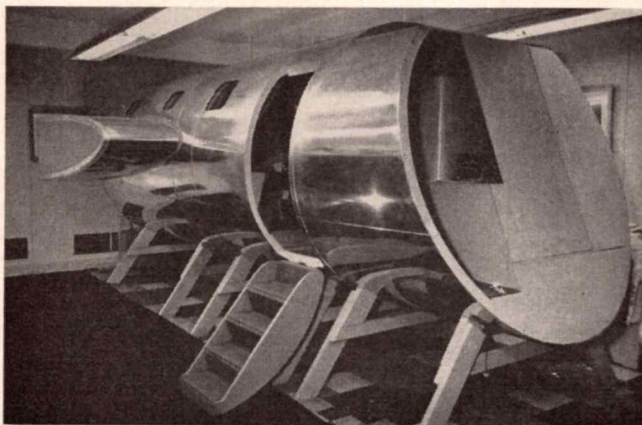


Fig. 2. Eye-appeal is helped by 3-D program

overall appreciation of engineering, shop and sales problems. Ingenuity and close coordination are the chief secrets of their success.

The basic function of this team is to produce layouts in the round—layouts developed by engineering in three-dimensions—that will embody practical solutions of particular problems with the utmost economy in days and in dollars. In practice, this unit has developed into a flexible three-purpose tool aiding in the solution of engineering, styling and sales-presentations problems.

The value of this program has been demonstrated again and again during the few months that the group has been fully in operation. Many human engineering problems have been solved—problems such as comfortization, which otherwise would have remained to haunt the production line, in terms of engineering changes.

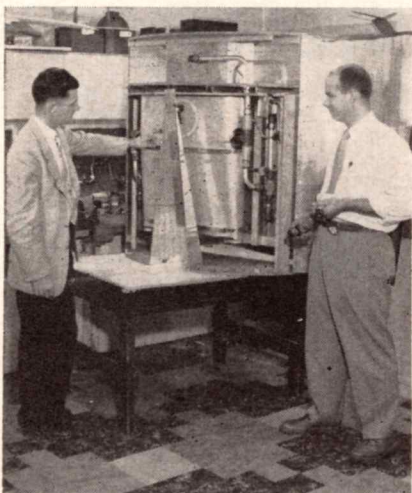


Fig. 3. Author (right), discusses 3-D sump tank design with project engineer

The recent development of the B-57 combat transport airplane provided an excellent challenge to the 3-D layout team. A full-scale replica of this modification of the basic intruder bomber configuration was needed as a sales presentation item. Engineering details had not yet been undertaken. The budget was extremely limited. Time for completion was set at a maximum of four weeks. Ingenuity and tight teamwork were called upon—and the job was completed on schedule and in a highly professional manner (Fig. 2).

Within that four weeks, a static idea was transformed by a 3-D layout into a living project with a

tangible piece of hardware capable of pointing up structural modifications, equipment relationships and the treatment of lighting, materials and color—all in terms that everyone could understand. Yet there is no mystery about the achievement, for the procedure used by the 3-D team was simple and straightforward.

Economy in time and money was realized in three ways:

(1) Material-acquisition time and cost were cut by the wholesale use of available scrap;

(2) Engineering time and cost were reduced tremendously, since no formal engineering mockup drawings were made; and

(3) Shop time and cost were minimized, because countless hours of wood sculpturing were eliminated by the decision to revise and adapt existing junk-yard parts—such as window frames and seats, heating, ventilating and lighting equipment.

When any difficulty arose, the 3-D layout men—located centrally among the engineering offices—were able to check at first hand, in a matter of seconds, with the design engineer or the project engineer concerned. Errors and unacceptable arrangements thus had no chance to develop into costly changes. In short, the 3-D layout shop doubles in brass as a convenient clearing house for the ideas expressed by the shop, by engineering, by sales and by management.

This opportunity for collective expression has a significant by-product value in elevating morale and in creating a better understanding between these groups.

In another recent design study, the ability of the 3-D layout team to break engineering bottlenecks and to reduce expensive 2-D layout time was clearly demonstrated. The congested sump-tank area in an aircraft structure was being designed by conventional 2-D methods. It became apparent, due to its complexity, that the whole design was precariously poised between success and failure. If all the tubing and wiring runs could be crammed through the structure in a certain area, the original trend of thinking could be maintained—but if not, a new approach would have to be made. This

would delay schedules and prejudice the aircraft's ultimate performance level.

The 3-D team undertook the job, relieving the layout man of the painstaking, time-consuming paper work of checking the tubing runs through this complicated structure. But the model had to be correct in every detail. Tubing, wiring valves and structure had to be authentically and accurately simulated in the round. Five days was all the time available under the schedule—but the job was completed on time. Actually, the feasibility of the design became clear to the engineers several hours before the model (Fig. 3) was finished.

All this was made possible by excellent coordination between the engineer most familiar with the project and the 3-D liaison people, who have a knowledge of all of Martin's vast facilities at their finger tips. For example, the acquisition of specially tailored parts and hard-to-come-by materials ceases to be a problem when negotiations, in each case, are made directly with the right man.

The necessity for the team to maintain an intimate familiarity with engineering factors, shop capabilities and the Company's sales programs, has made 3-D layout a natural and welcome aid in the styling of aircraft. However, unlike automobile styling, aircraft styling suffers severe limitations because of aerodynamic, structural and specification restrictions. As a result, in a strict sense, it is largely a by-product of function. It is imperative, nevertheless, that styling considerations be well represented in aircraft design. The only way to accomplish this, is to expose the design to the influence of industrial designers—men who are trained in correlating utility with esthetic appeal.

Engineers, too often, are completely preoccupied with structural or mechanical problems. They fail to consider fine-line adjustment—overlooking the fact that this may be all that is needed to make their design wholly desirable from the customer's point of view.

The 3-D layout medium creates lasting impressions and promotes sound selling through the office of customer participation. END

AERO DIGEST

design forum

WINNERS

OCTOBER, 1954 CONTEST

IMPROVEMENTS for light-planes took top honors in the October AERO DIGEST Design Forum, with two of the winners coming from the East Coast and the third from California. The competition closed Nov. 1.

The current competition has two more monthly awards to go, with awards totalling \$475.00 each, winners to be announced in the December and January issues. February issue of AERO DIGEST will bring the announcement of the 1954 Annual Awards, totalling \$1,625.00, with a First Prize of \$1000.00, a Second of \$750.00, a Third of \$500.00 and three Honor-

able Mentions of \$125.00 each. Winners of monthly awards are eligible for the annual awards, but it may go to design ideas that have won no previous prizes.

First Prize of \$250.00 for October announced by the judges is a multi-purpose light unit for small aircraft to provide a wing-tip mounted position light and high intensity landing light. Winner for the idea is Kenneth E. Hodge, Research Department Aeronautical Engineer at Grumman Aircraft, Bethpage, Long Island, New York.

The design is to increase safety of night flying by eliminating the need to spot automobiles along unlighted runways, landing or taking off in the glare of fixed ground spotlights, and improvising landing lights on wing struts, landing gear, and fuselage.

The unit does a number of things, among them making it possible, with a minimum of work, to convert an aircraft with only position lights into one with position and landing lights. The units are easy to attach to wingtip mounting pads provided for position lights. Only one additional wire must be run through the wings for cockpit connections.

The landing light location also protects it from stone damage and propeller dazzle, and, in most high wing planes, removes the light-



Arthur A. Merry (left) receives his third prize check from Gordon Horsfall, AERO's Sales Manager. Mr. Merry's entry was a method of working jet engine metals

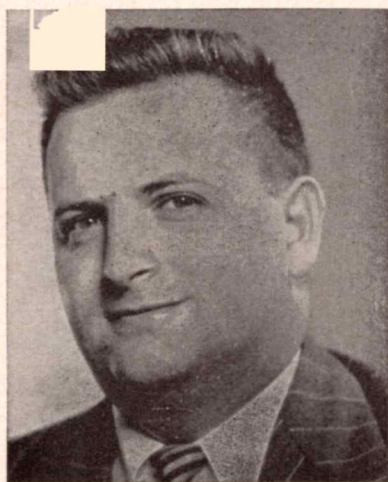
source from the pilot's view.

Final advantage is that power consumption is kept low by using 6-volt, 30-watt lamps from standard auto parts stock. For 28-volt operation, a 100-watt lamp is available.

Second prize of \$125.00 not only had the approval of the judges but was audited by Walter Jamouneau, Chief Engineer, Piper Aircraft Corp. A light airplane windshield, it was designed by W. W. Farr, Service Engineer, Rohm & Haas Company, Bristol, Pa.

The shield was designed as the result of difficulties with Plexiglas models which showed excessive deflection at high speeds. The center portion of the shield deflected inward several inches.

First prize last month went to Martin I. Kurke for his entry, "Qualitative Instrument Face"



The problem was to improve the structural properties without increasing weight, cost or mounting complexity.

The winning AERO DIGEST design surmounts this problem by applying air under pressure between the surface of the male form and the heated Plexiglas sheet during the forming operation to "free blow" the center section to a crowned surface tension shape in order to produce a self-stiffening domed contour.

When the center was crowned two inches above the mould contour, the windshield became rigid and did not deflect or "oil can" even at terminal dive speeds.

Optical properties were improved over the central area because there was no "mark off" from contact of the heat-softened Plexiglas against the mould surface. The same blank was used, matching the former model in weight and cost. Mold changes consisted only of the addition of clamps to hold the heated sheet around the edges to retain the air under pressure, and

an airline and valve. No change was needed in the method of mounting the windshield.

Third Prize of \$100.00 went to David Merritt of Consolidated Vultee Aircraft Corporation for his gap constrainer to take the initial shock off the shank of a rivet so inner surfaces of metals are compressed together prior to and while forming shop head.

Claim of the design is that it will close and hold tightly together the gap between inner surfaces on the impact of the rivet gun with bucking bar against the gap constrainer. The constrainer then compresses as it crumbles, and the normal riveting process is then accomplished. The method would work equally well using a squeezer.

The design idea came to the author in 1952, when he was working on clean-up on inspection items on the R3Y.

"The majority of squawks concerned shank rivets," he reports. "I experimented with hard rubber cloth cork and paper and found difficulty with all of them, but the

paper when made into a tube "wet" of the right wall thickness worked fairly well, but too slow to be practical.

"The sleeve wall thickness should be approximately 3/16 in. Material used should have a low shore value, such as one of the epoxy resins, nylon or teflon."

Announcement of October winners was accompanied by the retirement of Robert McLaren, former editor of AERO DIGEST, as one of the judges. He will be replaced by Fred Hamlin, now editor. Beginning with the November competition, another judge will be added. He is William Beller, new managing editor of the magazine.

Any citizen of the United States who is not a staff member or a relative of a staff member of AERO DIGEST is eligible.

Entries are judged on the degree to which they improve flight safety, reduce airplane complexity, or provide a manufacturing cost saving through engineering judgment and the application of technical skill.

First Prize • \$250.00

MULTI-PURPOSE LIGHT UNIT FOR SMALL AIRCRAFT

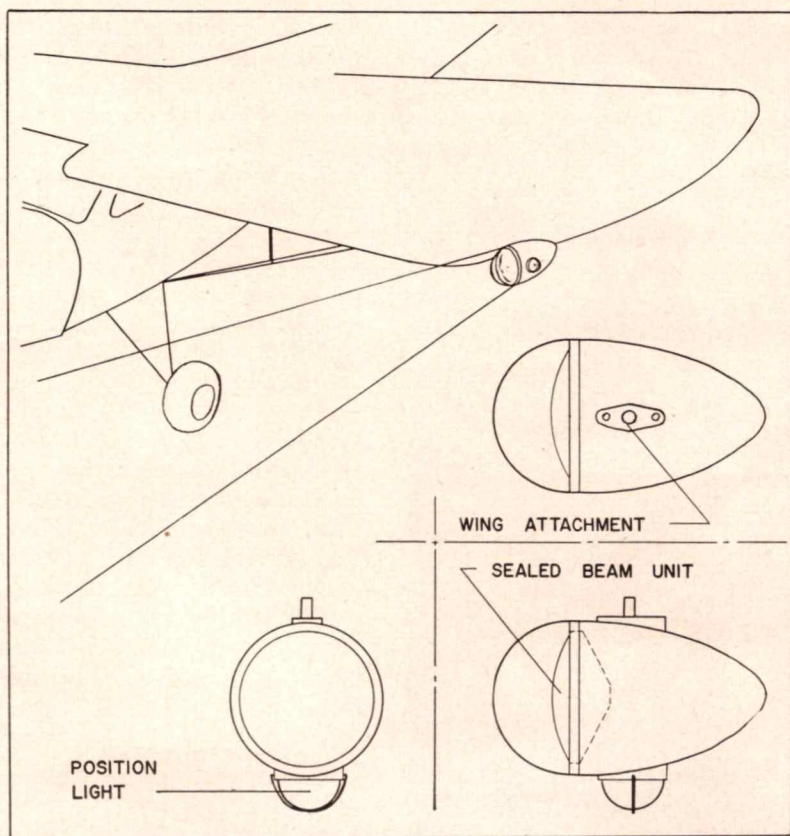
Kenneth E. Hodge

Aeronautical Engineer

Research Department

Grumman Aircraft Engineering Corp.

Bethpage, Long Island, N. Y.

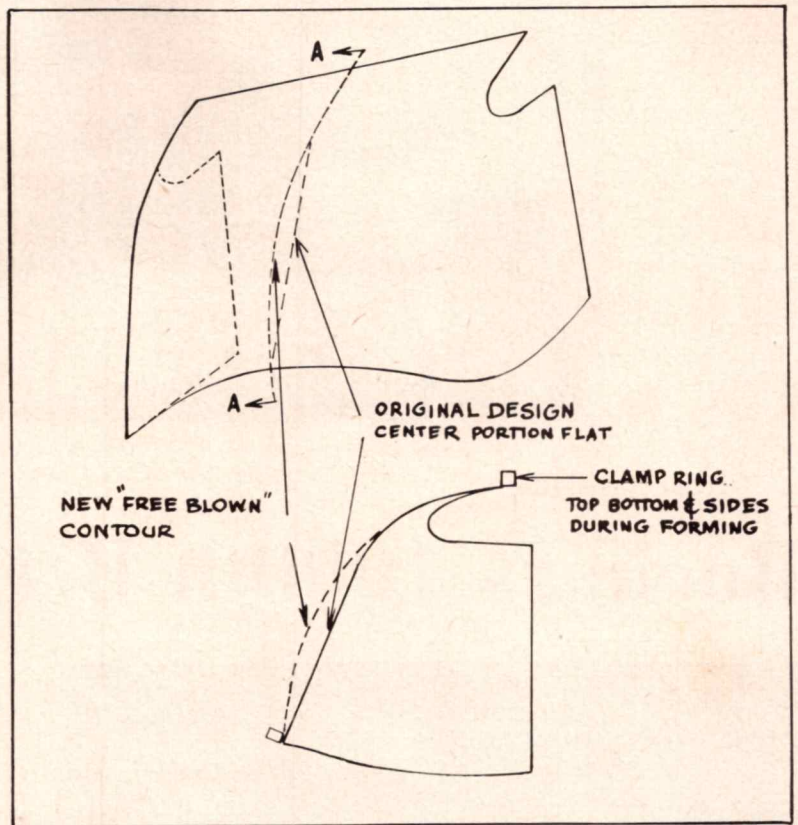


Second Prize • \$125.00

LIGHT PLANE WINDSHIELD

W. W. Farr

Service Engineer
Rohm & Haas Co.
Bristol, Pa.

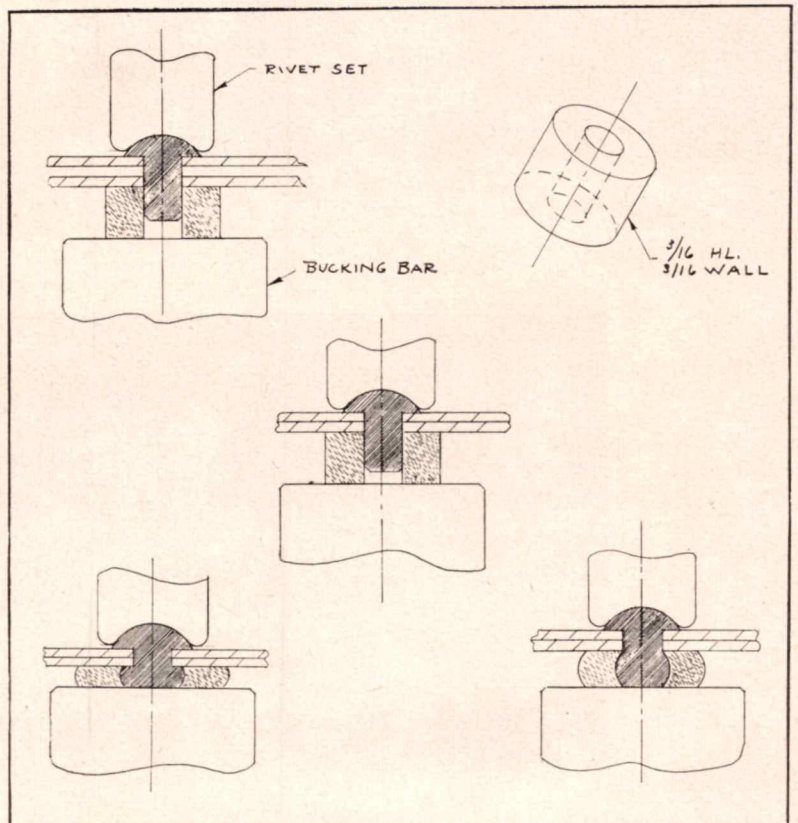


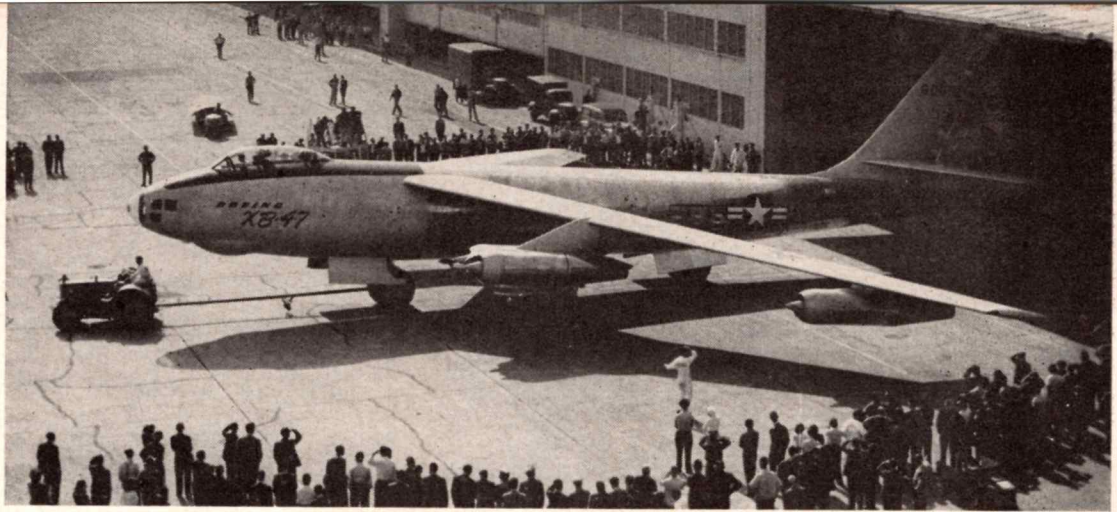
Third Prize • \$100.00

GAP CONSTRAINER

David Merritt

Consolidated Vultee Aircraft Corp.
San Diego, Calif.



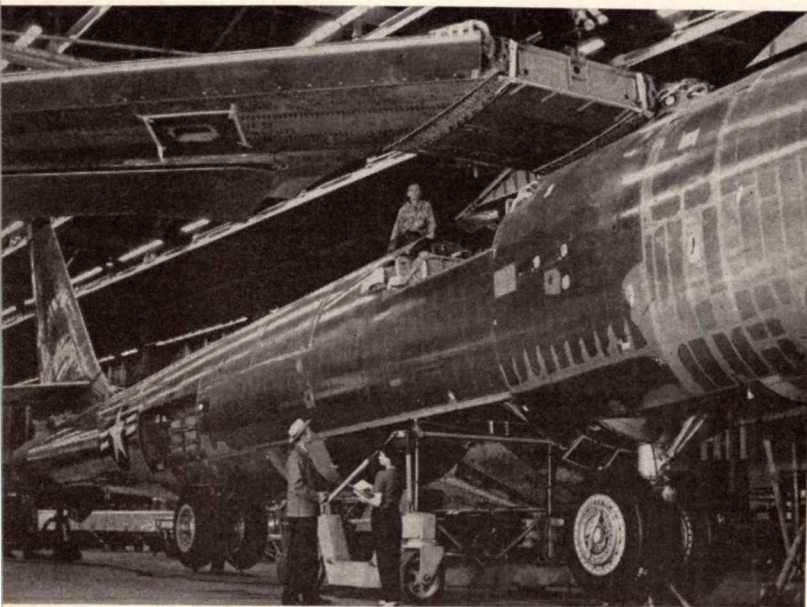


The first of the jet bombers, the XB-47 rolled out of the hangar September 12, 1947 to be followed by a thousand production models in a little over seven years

Boeing's 1000th B-47

THE Boeing B-47 *Stratojet* medium bomber represents the first combination of a virtually unknown kind of powerplant—the turbojet engine—to a new type of airframe depending for high-speed flight on a thin, flexible, swept wing.

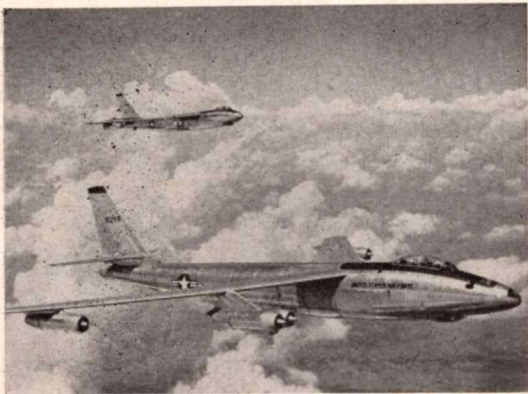
The swept wing was developed from designs based on American theoretical sweptwing data. It was proved in a thorough wind tunnel test program which made first use of models duplicating the flexibility of the actual airplane structure. A method was devised for mounting the jet engines—in “pods” supported on struts below and forward of the wing—so that they not only did not interfere with air flow around the wing, but also could be so positioned along the wing that they damped out any structural instability and per-



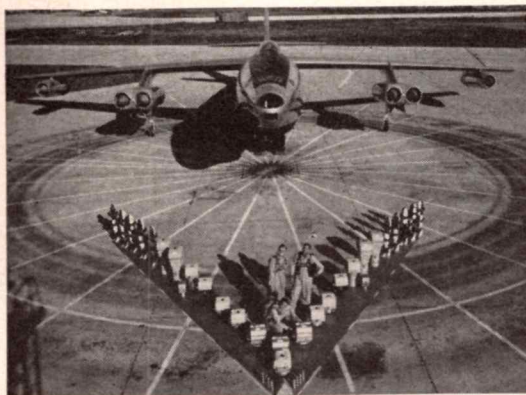
This 16,000 lb. 116 ft. wing is lowered to join fuselage in unique final assembly operation



The drag chute proved an effective braking device early in the B-47's history



Present production models are RB-47E photo airplane and B-47E medium bomber



RB-47E carries seven cameras per mission with crew of pilot, co-pilot and photographer-navigator

mitted extremely high speeds for an airplane of this category.

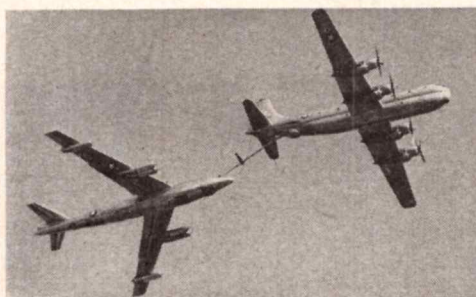
A landing gear housed in the wing would have meant thickening the thin wing, so Boeing engineers designed a tandem type gear housed in the fuselage, with outrigger wheels giving lateral support and retracting into the engine pods.

The significance of these and other engineering advances incorporated in the B-47 is seen in the operational success of that first large sweptwing aircraft to go into production—and the use in more recent jet airplanes of many such features as pioneered in the 47.

The B-47 demonstrated for the first time that it was possible to obtain high efficiency, long range aerodynamic characteristics in a practical wing which would permit very high speed flight. **END**

By **GEORGE S. SCHAIRER**

Chief of Technical Staff, Boeing Airplane Company



Aerial refueling from Boeing KC-97F has given the B-47 unlimited range



Final *Stratojet* assembly line shows still more to come

The 1000th B-47 was rolled out October 14, "marking the finest chapter in Boeing production," according to President Allen



New method under test to avoid deck warping caused by high angle of attack aircraft in catapult position

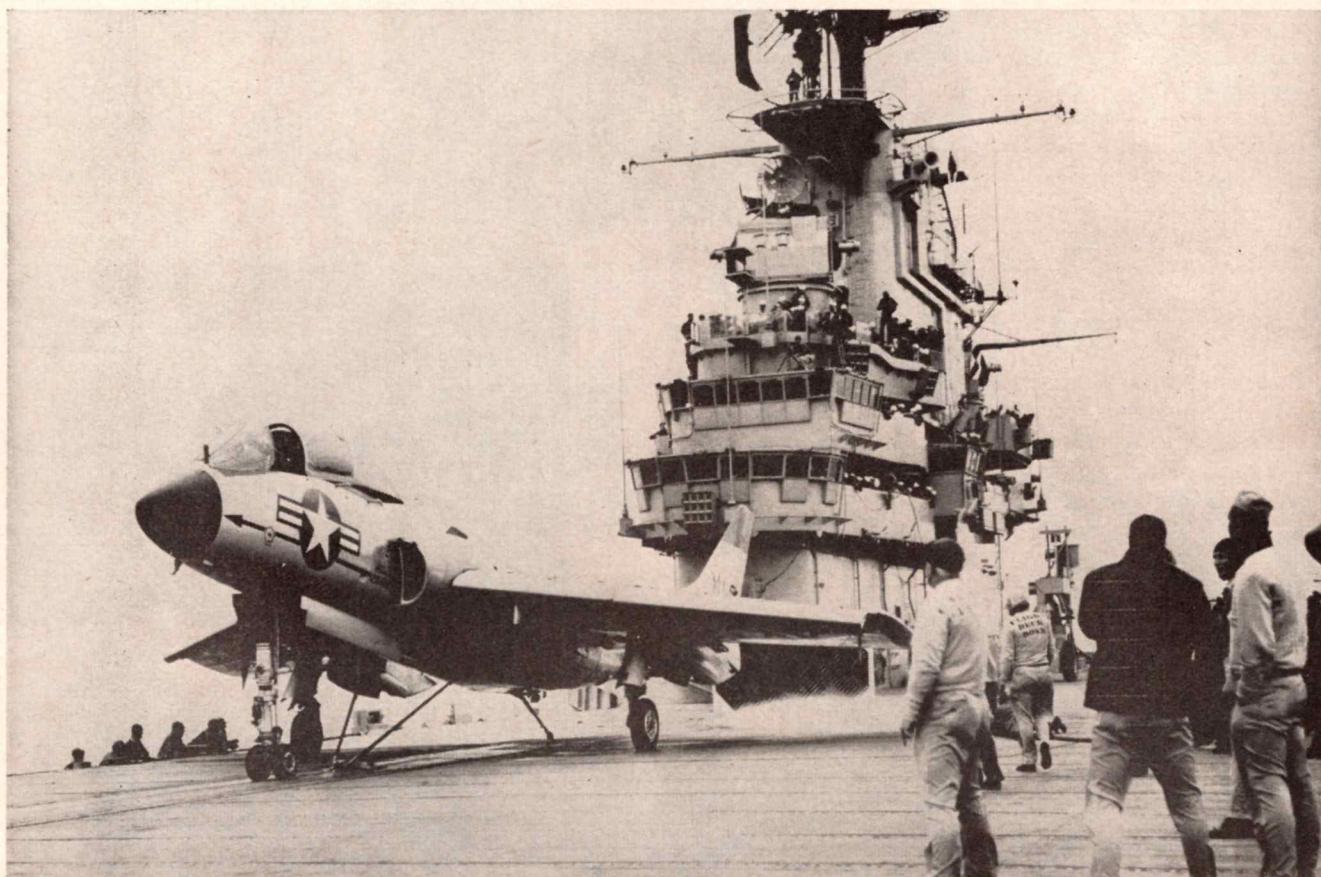
Water Cooling Jet Blast

By JUAN M. CAMERON

WATER-COOLED deck panels to protect ship's decks against the fiery exhaust gasses of turbojet engines — these are the Navy's newest innovation in adapting aircraft carriers to swept and delta wing aircraft. This month the first of these aluminum cooling panels, through which salt water circulates, will be installed aboard the aircraft carrier *Hancock* at the Seattle Naval Shipyard.

Designed by the Navy's Bureau of Ships and Bureau of Aeronautics to insulate the steel and wood carrier flight deck against engine exhaust from new high angle-of-attack aircraft in catapult position, these panels answer another of the problems naval aviation has faced in adapting old ships to new planes.

Tests with a F7U-3 *Cutlass*



High angle of attack of Chance Vought F7U-3 *Cutlass* on takeoff catapult produces terrific deck temperatures

aboard the carrier *Champlain* last winter brought to light the serious problem of deck heat. When the *Cutlass* was brought into catapult position, and its twin J-46-WE-2 turbojets were turned up to 100 percent power steel deck plates to either side of the catapult hold-back track heated up, and began

to warp. After launching, deck crews brought out fire hoses to cool down the deck, smoking from the exhaust heat.

Inspection showed the steel deck plates, themselves designed to shield the flight deck from heat, had cracked and buckled. Beneath these plates the douglas fir deck planking was charred by the tremendous temperatures. Deck-caulking had heated to the point where it blistered and ran. On the hangar deck beneath, paint was blistered and peeling.

Catapult crews working with tensioning bridles on the hold-back track found the deck too hot to work on. In sustained launching operations, high pressure aircraft tires would suffer damage passing over the hot deck. The danger to explosive laden aircraft this deck heat posed needed no underscoring.

The turbojet's heat and blast were not new problems to Navy engineers. But aircraft like the Chance Vought F7U-3, McDonnell F3H-1 and the Douglas F4D-1 were designed with extremely high angle-of-attack in catapult posi-

Set in square steel frames, louvers or turning vanes, tilted at a 45 deg. angle, directed the hot engine blast upwards and sideways. Set seven feet behind the catapult's hold back track's rear, the deflector, measuring twelve by six ft., intercepts about half the engine's blast, temperatures of which measure 750 deg. C. seven ft. from the tailpipe—550 deg. C. at fifteen ft.

The louvered-screen deflector was considered a palliative, not a cure. For one thing, wind over the flight deck often turned the deflected exhaust gasses downwards—sometimes into areas where aircraft were warming up. The solution was to remove the exhaust from the flight deck.

One attempt to do this was fitting a large portable duct resembling a cornucopia to the aircraft's tailpipe at the rear of the fuselage. The duct was to intercept the exhaust, whose temperature at the interception point was 1300 deg. C. and carry it up and over the side of the ship. Because of its size—this duct was more than 20 ft. long and eight ft. high—and the difficulty of adjusting it to dif-

Aboard the *Hancock* six aluminum panels covering an area of more than 430 sq. ft. will be set into the deck to either side of the catapult hold-back track. Salt water, circulating at a water velocity of five fps through the honeycomb panels, will maintain 160 deg. C. deck temperatures during launching operations.

The panels' ability to cool varies directly with the water-flow rate. A flow of 470 gpm will maintain the aluminum surface temperature at 205 deg. C. under prolonged afterburner operation. When the flow of water drops, for instance, to 54 gpm, surface temperatures rise to 375 deg. C. with afterburner operating.

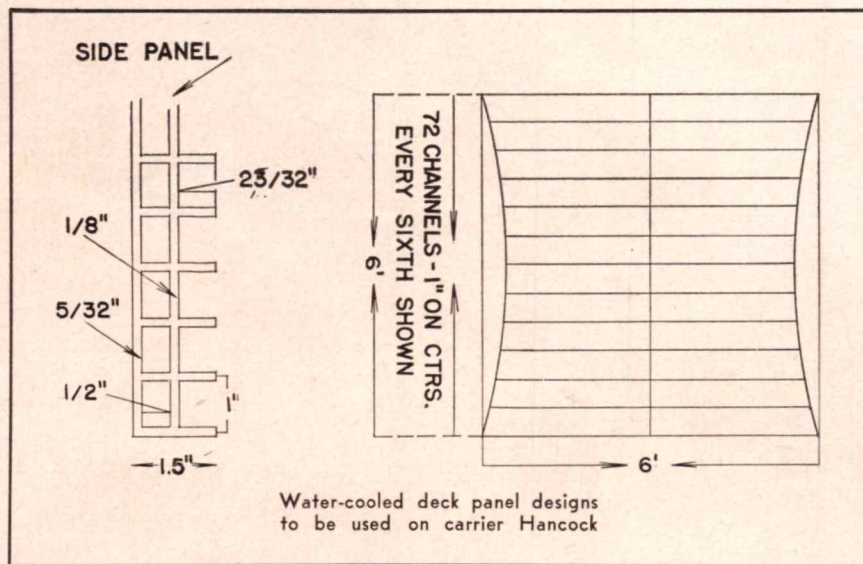
Set flush with the deck, the inch and a half thick panels will be placed over the steel deck, with a three-quarter inch douglas fir filler in between. Encircling the panels, a waterway channel drains away the salt water pumped through the small ducts.

Exhaustive tests have been made with the panels at the Naval Air Test Center, Patuxent River, Md. under various engine settings. Besides being able to cool down the deck under any blast, the panels proved able to withstand shear and compressibility strains up to 78,000 lb.

Successful as the new deck cooling system appears to be, the problem is not completely solved. Engineers are studying the effect the exhaust of single-engine aircraft like the F4D-1 and F3H-1 will have on the hold-back track itself. These aircraft's exhaust will not straddle the hold-back track, as in the case of the twin-engined F7U-3. It may be necessary to encase the hold-back-track in a water-cooled jacket, an extremely difficult engineering problem.

This problem of deck heat is one of the over-all jobs of adapting carrier to modern aircraft. The job is far-reaching, as can be seen in the modernization programs underway on many World War II aircraft carriers now. As one Bureau of Ships engineer commented, it is necessary to make changes—either to redesign or modify—our carriers to meet the requirements of each different type aircraft now reaching the Fleet.

END



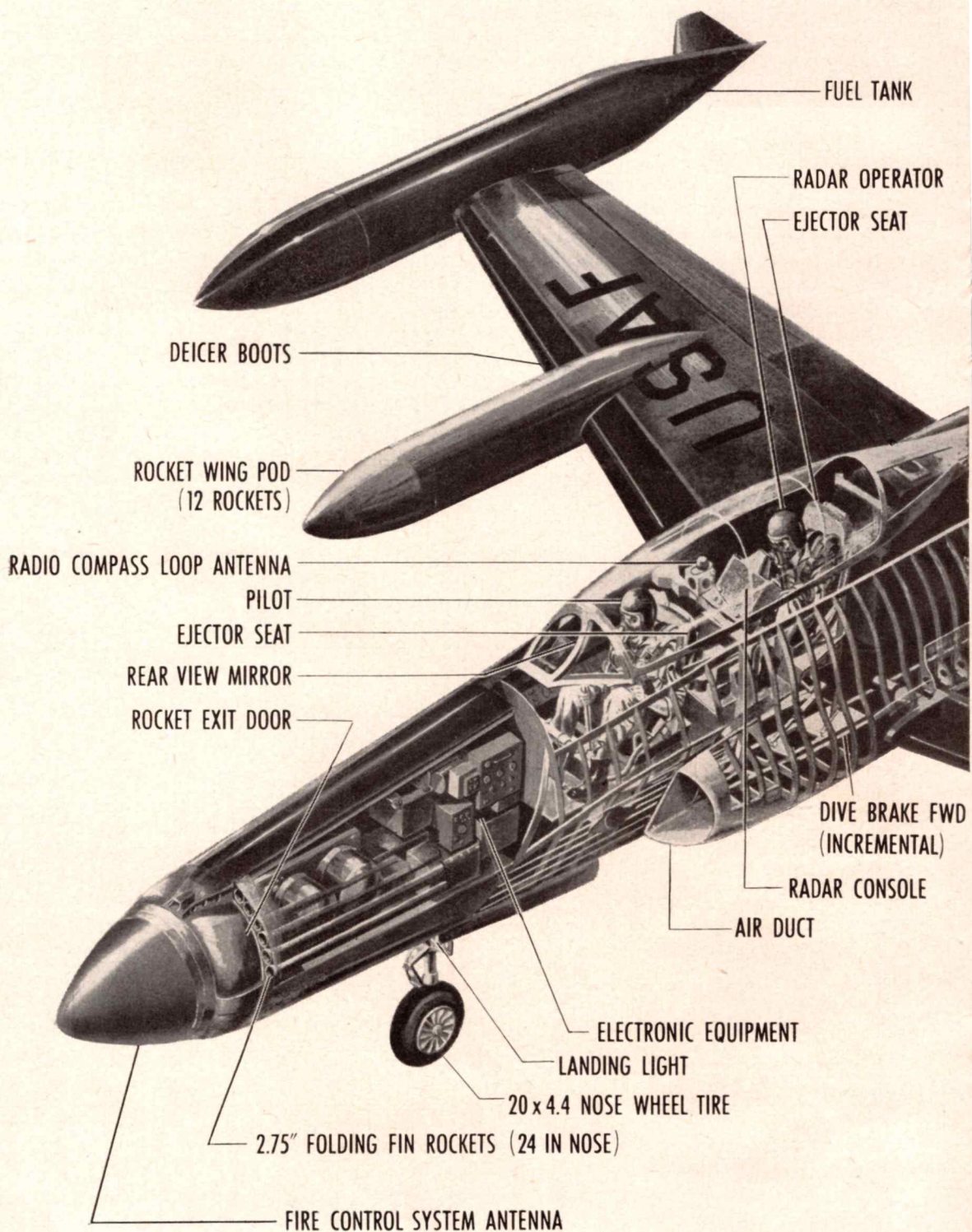
tion. Consequently, the exhaust, which passed horizontally over the deck formerly, was now aimed directly down on the hold-back track area.

Until delta and swept-wing aircraft made their appearance in the Fleet, the problem of jet blast has been dealt with by means of louver-type deflector screens located behind the catapulting area.

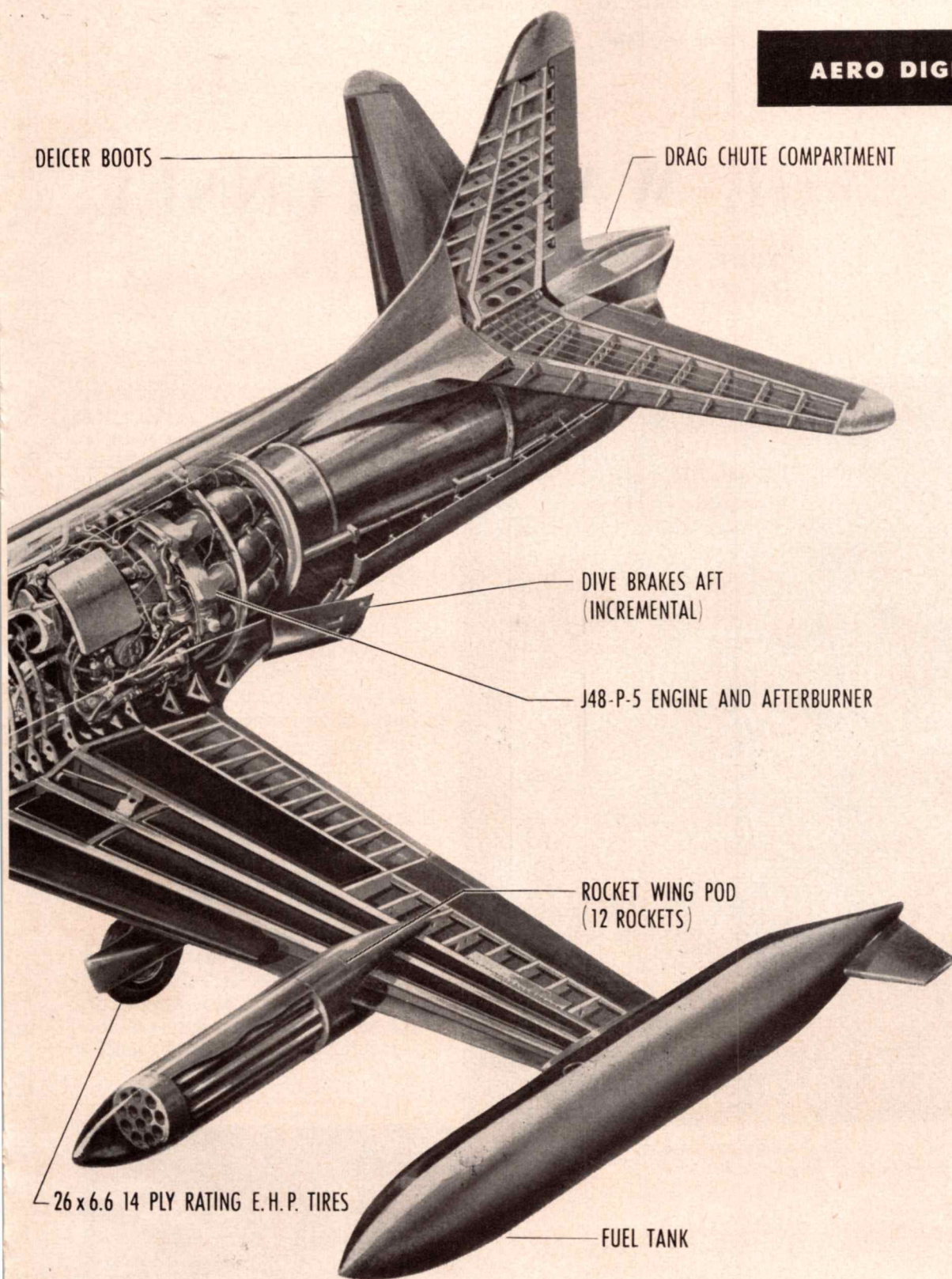
ferent aircraft, this scheme was unfeasible.

Deck heat was another aspect of the general problem of the turbojet's blast. Aircraft with a take-off attitude of 20 to 24 deg. above the horizontal brought the problem to a head.

Navy engineers finally decided on the water-cooled deck as the best solution to exhaust heat.



LOCKHEED F-94C STARFIRE



Little-known research tool seen as a successor to some of the more conventional research facilities

THE WATER TUNNEL:

By J. M. ROBERTSON

Professor of Engineering Research, Pennsylvania State College

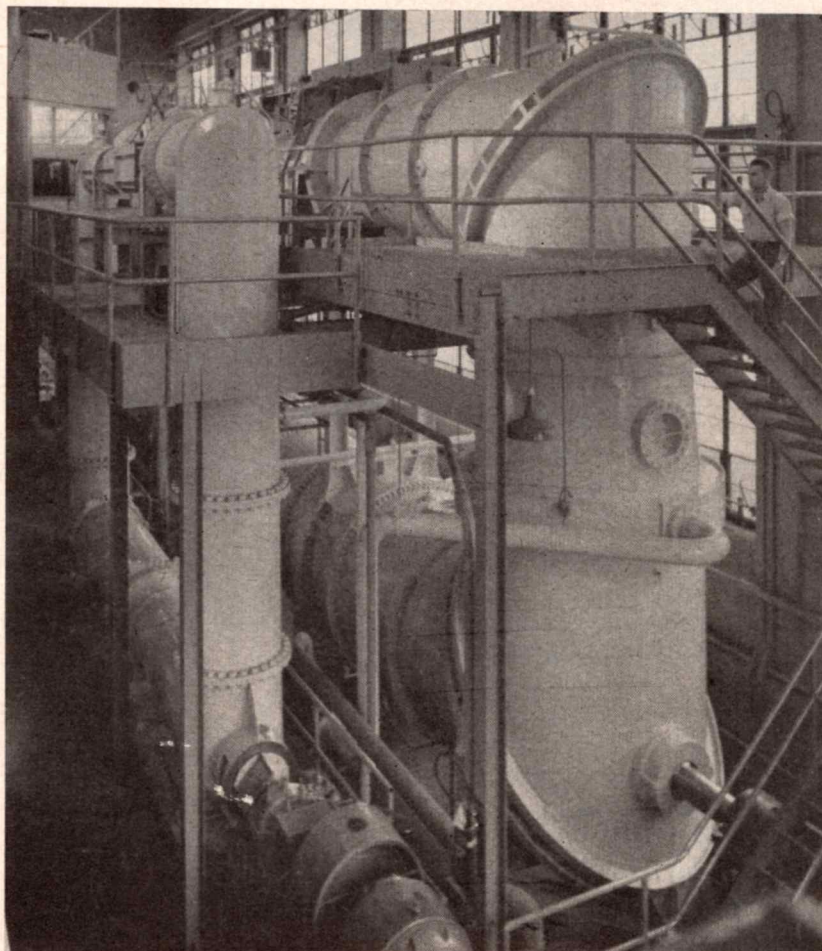
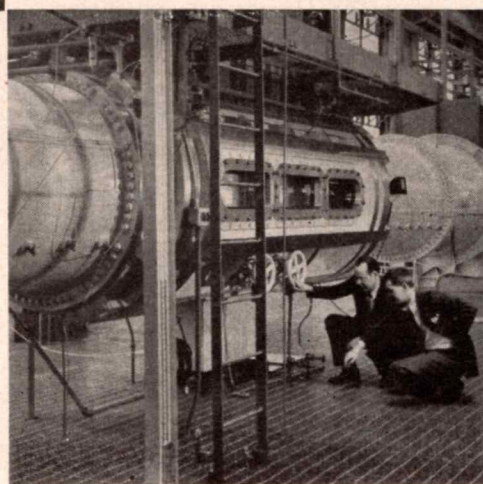


Fig. 1 Tunnel bay of the Garfield Thomas Water Tunnel showing both water tunnels

THE water tunnel is the hydrodynamacists wind tunnel. It is usually similar in circuit construction to a subsonic air tunnel except for its heavier structure necessitated by the greater density of the medium contained in it. It also is always constructed with a vertical rather than horizontal circuit as in most air tunnels which lay flat. This is done to help prevent the occurrence of cavitation troubles at the pump which pushes the water around the circuit. Like air tunnels, water tunnels may have open or closed-jet working sections which are usually circular in cross section. In this country there are about a dozen water tunnels of throat diameter between 10 and 48 in. There are probably again as many water tunnels in the rest of the world.

Pennsylvania State University has one of the Pergest. From the circuit diagram for this tunnel, shown in Fig. 4, one may see its close similarity to the subsonic closed circuit air tunnel. In general

Fig. 2 Working section of 48-in. tunnel



Tool in Aerodynamic Research

the various elements of the circuit, the nozzle, working section, diffuser, turns, etc., are designed as they would be for air, with little concern for the different phase of the fluid medium. In some parts of the nozzle, diffuser, and turns special attention was paid to avoid high localized velocities to prevent cavitation in the water. The propeller-type pump which circulates the water is driven by a variable-speed motor giving range of working section velocities from 0 to 83 fps.

Cavitation is a boiling-like phenomenon which occurs in a flowing liquid when the local pressure is reduced to vapor pressure. This is because ordinarily water

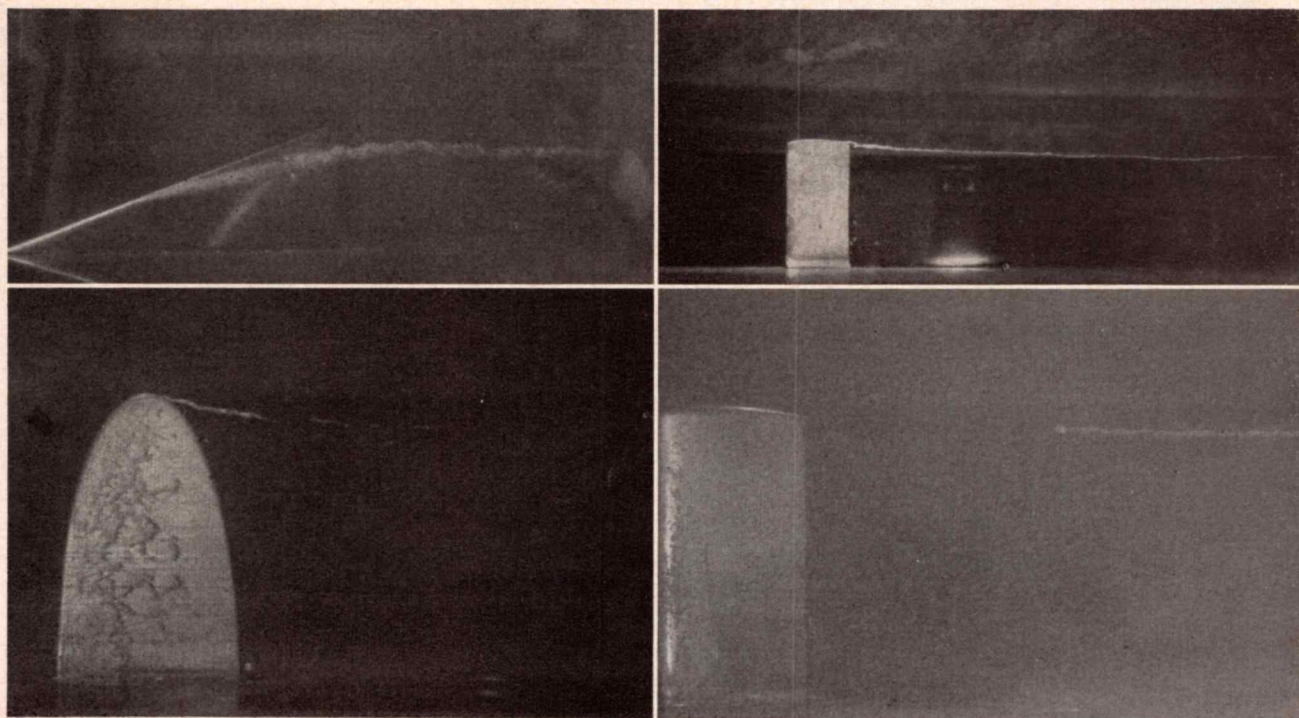
cannot withstand a tension and will break and form a cavity before this occurs. Naturally cavitation first tends to occur on or near a body where the local velocity is highest, and for any flow condition its occurrence is dictated by the ambient pressure.

For cavitation testing a water tunnel should permit control of the pressure in the test region. In the 48-in. water tunnel the range in pressure is 3 to 60 psia, independent of the test velocity. The temperature of the water can be varied from 40 to 110 deg. F. with the aid of heat exchangers and a 350-ton refrigeration machine for cooling purposes. This also permits a two-fold variation in fluid viscosity.

The Penn State 48-in. water tunnel is constructed of $\frac{3}{8}$ to $\frac{9}{16}$ -in. thick steel plate except for the end of the nozzle, the working section, and transition section into the diffuser which are heavy bronze castings machined to close tolerances. Fig. 1 is a photograph of this tunnel, and an auxiliary smaller one, giving an idea of the nature of the shell structure and the orientation of the tunnel. A closeup of the working section for the 48-in. tunnel is shown in Fig. 2.

For many years in aerodynamic research facilities there has been an attempt to get the highest possible Reynolds number for testing. Even today it is often desirable to be able to test at high Reynolds num-

Fig. 3 Tip vortices behind several wing shapes as shown by cavitation



bers without compressibility effects. The advantage by use of water has been obvious for some time, for water has a kinematic viscosity less than one-tenth that of air.

In light of today's knowledge of water tunnels, especially those with pressure control systems, it appears that a water tunnel should be usable to increase the range of available Reynolds numbers. Some such computations are summarized in the accompanying table. In these the Reynolds number per unit length of the body (one foot) has been computed for reasonable values of the air and water velocity. The available Reynolds number in a water tunnel is between three to nine times that in air. The last item in this table shows that the power required for a water tunnel test at this high Reynolds number is as much as 20 times as great. This is proportioned to the amount one would have to increase the size of the air tunnel to achieve the higher Reynolds number avail-

able in the water tunnel.

There is an analogy between some features of cavitation in liquids and compressibility in gases. In the case of cavitation, trouble first occurs at the point along or near the surface of the body where the local velocity is highest. This is exactly the point where shock waves first give trouble. The body or airfoil more suitable to delay as long as possible the first occurrence of this

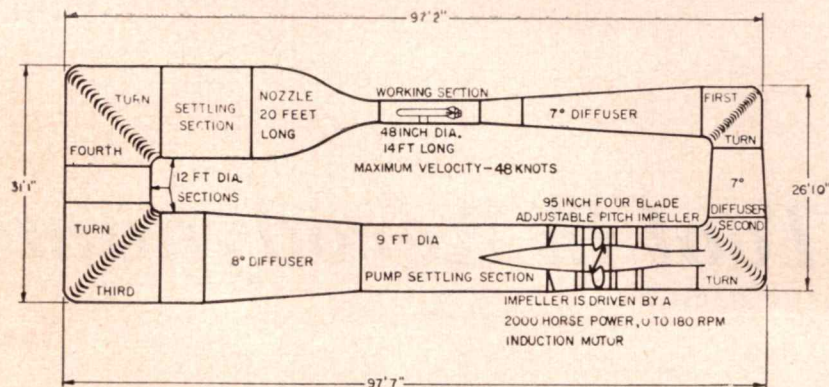


Fig. 4 Circuit of the 48-in. water tunnel

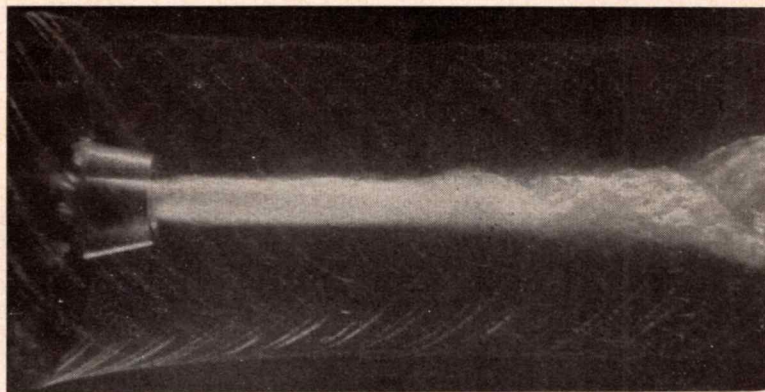


Fig. 5 Wake contraction behind a single propeller illustrated by counterrotating propellers as shown by cavitation

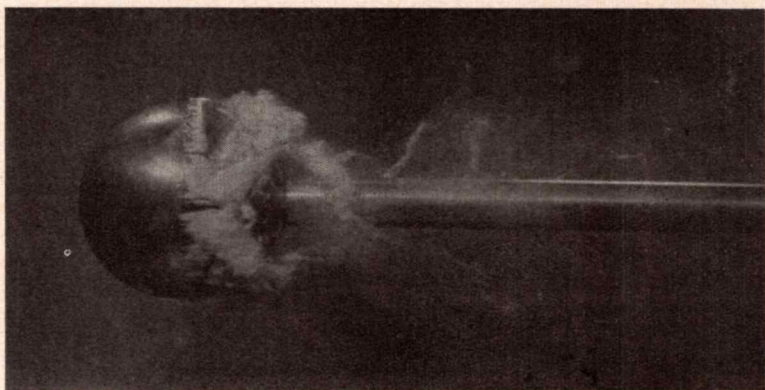


Fig. 6 Cavitation on a 2-in. sphere at 58 fps and 20 psia

trouble in either case is one of constant velocity along the surface. During the war, Reichardt in Germany used water tunnel cavitation studies to develop shapes for high velocity (near sonic or transonic) aerodynamic parts. This was done by putting the desired nose shape in the flowing water and then raising the water velocity and lowering the pressure until a cavity was caused to exist behind the shape. A photograph of the cavity shape produced gave the coordinates for a body which had essentially constant velocity along its surface. This constancy of velocity along a surface of a cavity occurs because the phase inside the cavity has a negligible density compared with the liquid phase and the pressure at the interface is constant. Due to the constancy of energy along streamlines the velocity is essentially constant. The clear cavity drawn behind a simple object such as a disc is shown in Fig. 7.

The occurrence of vapor filled cavities in flowing water or air bubbles injected or released by the cavitation phenomenon is available to the experimentalist to indicate the flow conditions occurring. Typical examples of flow visualization are the occurrence of vortices behind tips of propellers, turbulence in wakes behind bodies, and indications of structure vibrations associated with wakes. Information on the flow conditions behind wings and propellers is very easily obtained from observation of the cavitating tip vortices behind such objects. Fig. 3 shows the tip-vortex cavitation occurring at and behind several different wing tips. The nature of the flow orientation is clearly delineated by the cavity at

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the core of the vortex. In the case of the triangular planform wing the occurrence of separation in the region somewhat inboard from the tip is evidenced by the nature of the cavitation there. In the case of one of the rectangular planforms shown, the fact that the vortex did not appear to start until about $1\frac{1}{2}$ chord lengths behind the wing tip suggests that the vortex has not sufficiently rolled up before reaching this point so as to produce the necessary negative pressure to cause cavitation to appear.

Other data from observation of propeller vortex cavitation is the

Fig. 7 Clear cavity drawn behind a 6-in. disc in water tunnel at about 60 fps



contraction in the flow field behind propellers. This is predicted by momentum theory but an exact indication of it experimentally is not easily obtained. Fig. 5 shows how cavitation can be used to display this flow contraction. This picture was obtained by taking multiple exposures of the flow behind an 8-bladed propeller with tip vortex cavitation.

Cavitation also appears to be a promising tool to use in obtaining indications of the nature of turbulence and wake flow behind bodies. The Fig. 6 illustrates severe cavitation occurring on a two-inch sphere being supported in the tunnel. The flow pattern illustrated is interesting in terms of the isolated vortex cores which are occurring a little distance behind the end of the major amount of cavitation.

Another type of flow visualization which has been suggested by water tunnel tests is the visualization of the flow in a turbulent boundary layer along a surface. Fig. 8 shows the flow past the downstream end of an axially symmetric body. Cavitation was occurring upstream which was appar-

ently releasing small air bubbles from solution. The turbulence in the boundary layer seems to have very thoroughly distributed these bubbles across the layer and they appear to indicate rather satisfactorily the extent of the boundary layer. Close scrutiny of the picture also reveals the intermittency of the outer edge of the turbulent boundary layer. In fact such flow visualization might be used to obtain a better picture of this phenomenon.

In water tests, cavitation has been used to indicate the occurrence of vibrations of the trailing edge of vanes or blades. A photograph illustrating the cavitation in the cores of the successive vortices in the trail behind a blade is shown in Fig. 9. It is possible that this technique might aid in studying certain aerodynamics problems of similar nature.

The possibility of using water tunnels for research on aerodynamic problems is not one with-

out certain problems. The first of these is that obtaining high Reynolds numbers requires considerable power. Another problem in water tunnel testing is that it is more difficult to properly support the test bodies because the density of water is the order of 1000 times as great as that of air. Even though air velocities are considerably larger, the dynamic pressure of the flowing water is many times greater than that for air.

In spite of these disadvantages, which are not insurmountable, it appears that the water tunnel is suitable to assist in a certain amount of aerodynamic research and testing. The chief areas in which the water tunnel can assist in aerodynamic research involves achievement of high subsonic Reynolds numbers, a facility for studying compressibility sensitivity in the near sonic region, and possibilities of using entrained gas or cavitation to visualize certain flow phenomena. END

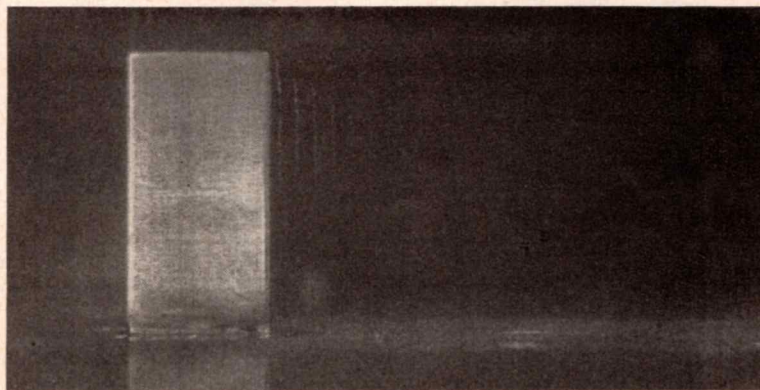


Fig. 8 Cavitation or air bubble showing the turbulent boundary layer on the tail portion of the body

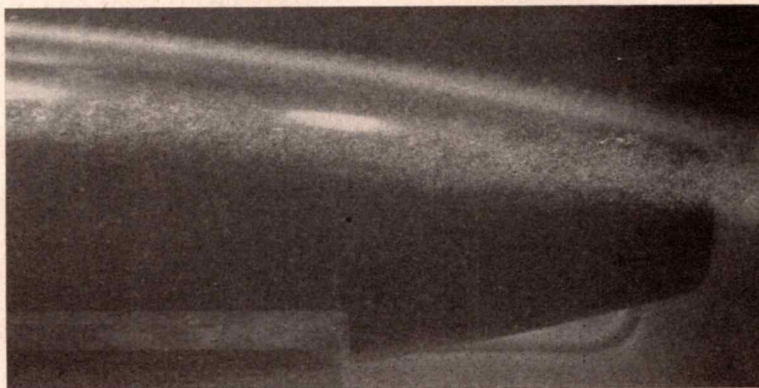
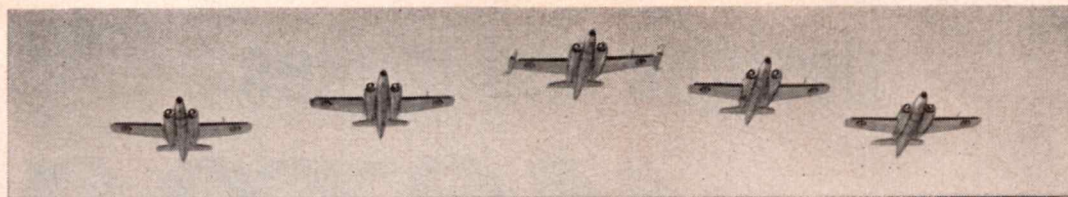


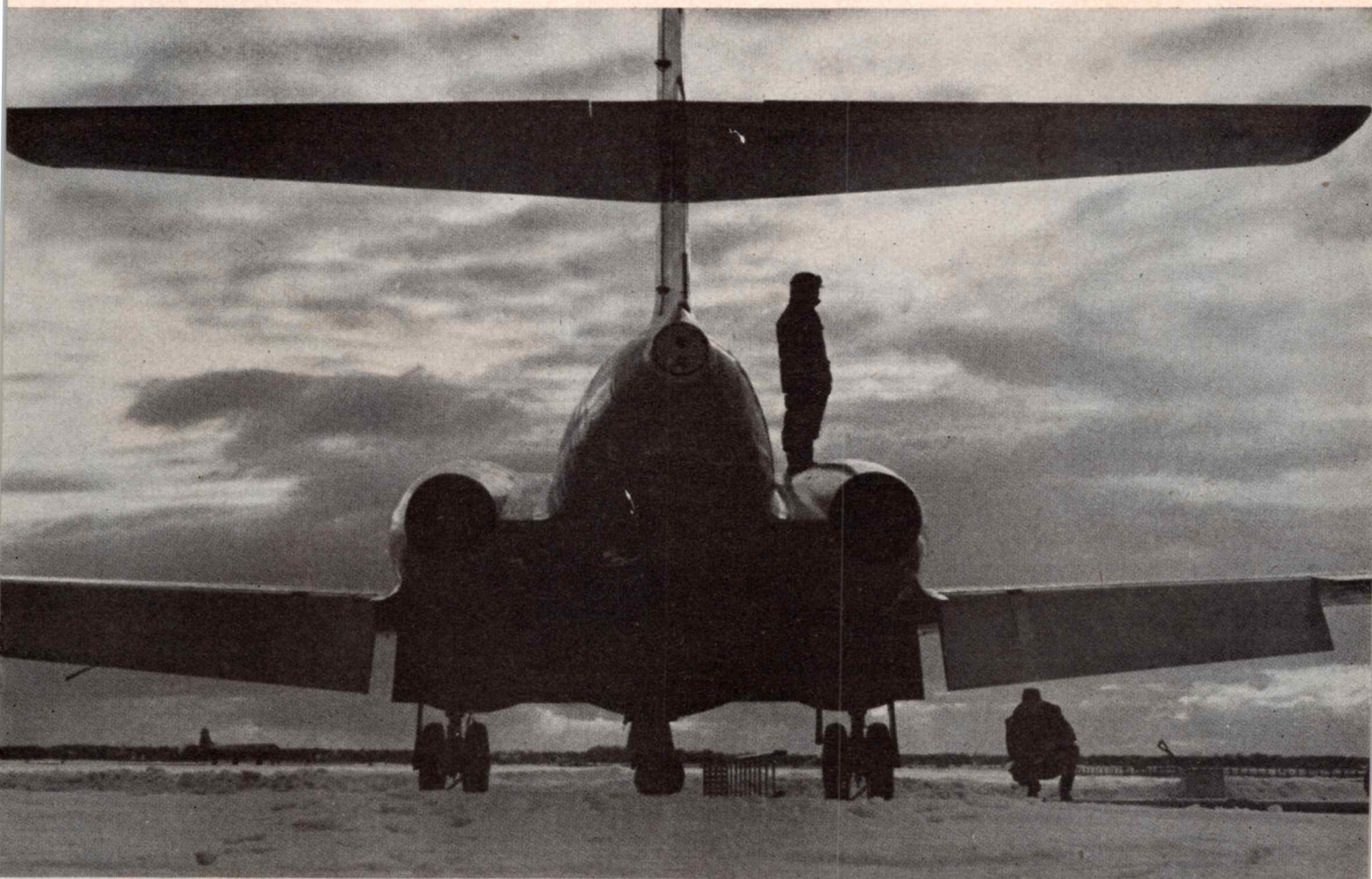
Fig. 9 Vibration of induced vortex trails behind a strut shape as visualized by the cavitation occurring in their cores

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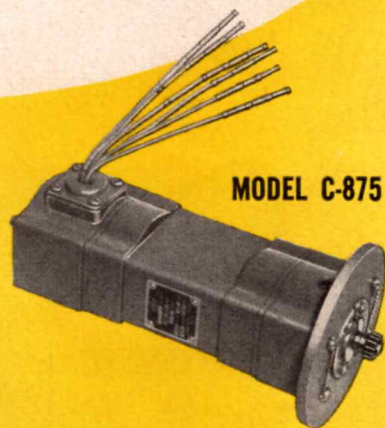
MODEL D-479



MODEL C-1076



MODEL
D-364



MODEL C-875

MODEL D-479: EMERGENCY MOTOR FOR HYDRAULIC SYSTEMS ON INTERMITTENT DUTY

Operates to 160°F. Ambient temperature on a duty cycle of 1½ min. at 25.6 inch lbs., 5 min. at 8.0 inch lbs., then 30 min. rest period. Turns up 5500 r.p.m. on 24 volt D.C. at 90 amperes, with 2.75 HP output. Explosion proof. Weight: 14.75 lbs.

MODEL C-1076: SMALL VALVE MOTOR

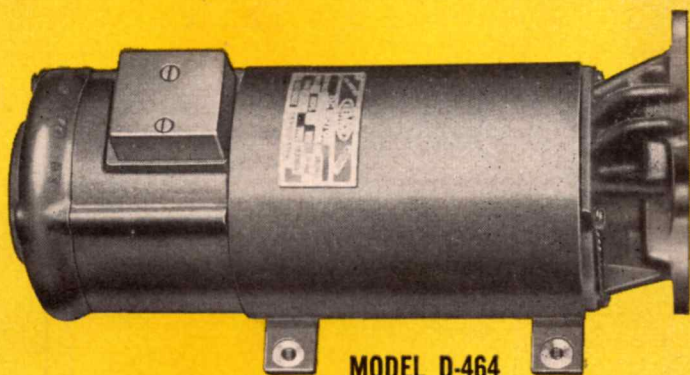
Only 2½" long x 1¾" x 1½"; weighs but 11.7 ounces. Operates on 26 volt D.C. at 2.9 amperes at 21,000 r.p.m. on split series, reversible. Output is 25 watts.

MODEL D-364: WING FLAP MOTOR FOR LARGE JET FIGHTER

Operates at 7400 r.p.m. on 26 volt D.C. at 62 amperes with 1.25 HP output. Has clutch and brake with static brake torque of 20 inch lbs., thermal protector, radio noise filter, is explosion proof. Weight: 11.2 lbs.

MODEL C-875: TWO SPEED RADAR ANTENNA AZIMUTH MOTOR

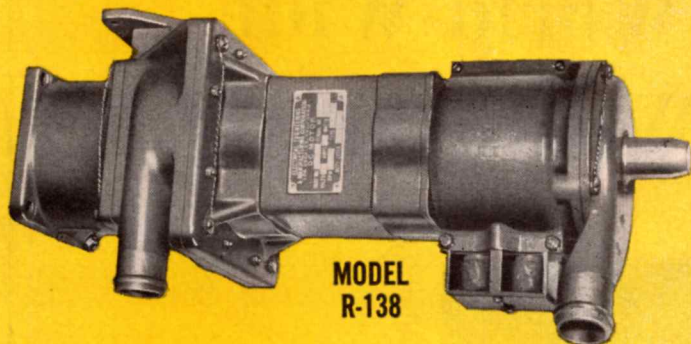
designed for continuous duty to operate at 3300 and 13,200 r.p.m. on 26 volt D.C. Rugged in construction, yet compact in size, it has a life of 2,000 hours. Weight: 2.75 lbs.



MODEL D-464

MODEL D-464: EMERGENCY STAND-BY MOTOR

for use on Supersonic Research Aircraft. Designed to operate at high ambient temperature of 70°C. at 50,000 foot altitudes. Duty cycle is 1 minute at 1 HP, 30 seconds at 2½ HP. High temperature materials used throughout. Motor weight, including gear box: 22½ lbs.



MODEL R-138

MODEL R-138: EXPLOSION-PROOF HYDRAULIC PUMP DRIVE

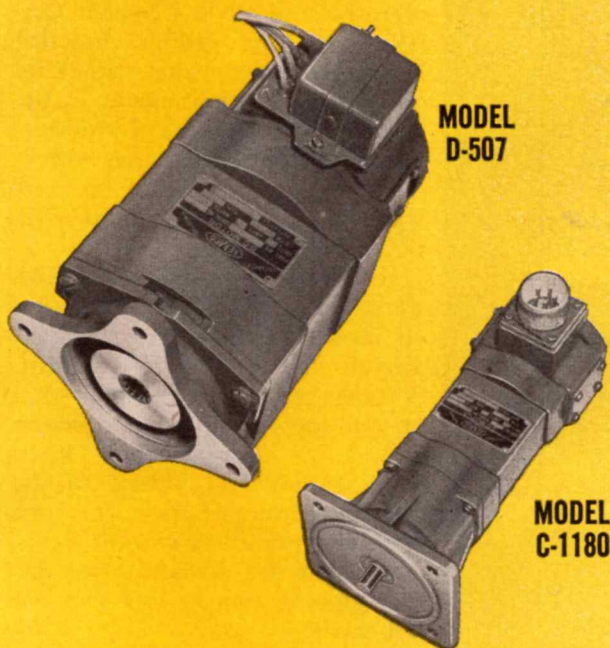
equipped with in-line gear reduction. Gear box designed to keep acoustic noise level at an absolute minimum. For continuous duty operation with duty cycle varying from 1½ to 5 HP load. Designed to operate for 2,000 hours without maintenance. Operates in a vertical position. Weight: 20½ lbs.



MODEL D-638

MODEL D-638: 400 CYCLE, 6.5 HP, A.C. MOTOR FOR INTERMITTENT DUTY

made to drive a hydraulic pump on a guided missile. Duty cycle is 3.0 seconds at 6.5 HP with 2250 r.p.m., 15.0 seconds at 1.5 HP. Has continuous rating of 5 HP at 2300 r.p.m., 15.8 amperes, 200 volts. Weight: 17½ lbs.



MODEL D-507

MODEL C-1180

MODEL D-507: MISSILE APPLICATION MOTOR

This 2 HP, 115 volt D.C. motor provides 12,000 r.p.m. on continuous duty. An internal spline drive within the armature shaft allows for a close coupled, extremely compact assembly to drive a 400 cycle, 3 phase permanent magnet alternator. Provision is made in motor winding to maintain constant output speed with varying conditions of voltage and load. Unit is equipped with radio noise filter. Weight: 15.5 lbs.

MODEL C-1180: STAND-BY MOTOR FOR HORIZONTAL STABILIZER

Has a duty cycle of 50 seconds on, 3 minutes off. Rated 13,000 r.p.m. on 25 volt D.C. at 21 amperes, with 0.5 HP output. Has 2 inch stack length. Weight: 4.25 lbs.

Designers and producers of
motors, linear and rotary actuators.

Electrical Engineering and Manufacturing Corp.

4612 West Jefferson Boulevard
Los Angeles 16, California

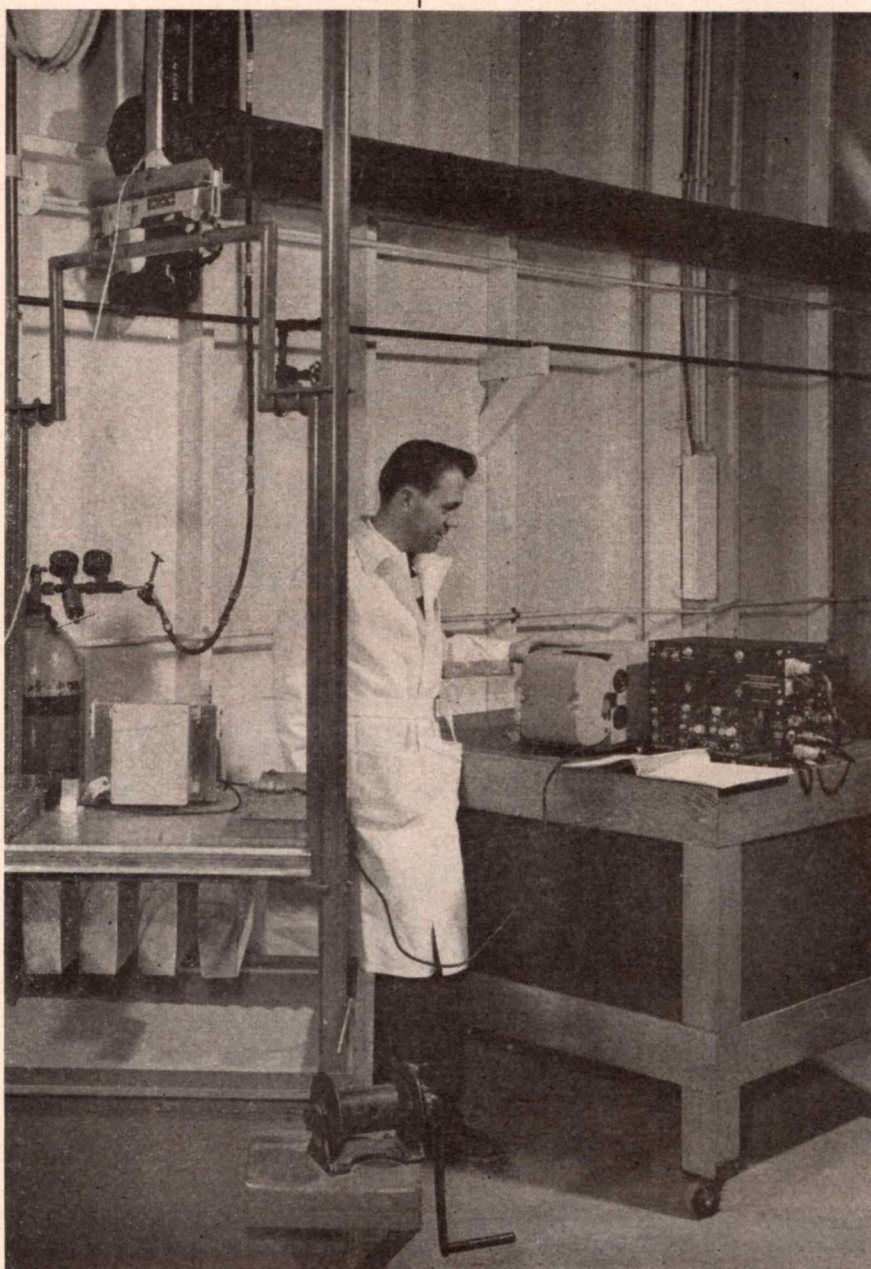


can supply a motor to fit your specifications

Wyle Laboratory specialists create weather
to order for testing all kinds of products

World-Wide Weatherman

By PETER L. SHUGART



SUPPOSE you manufacture a complex component for military aircraft or missiles. Do you want to know how your product operates aground or aloft, in the tropics or at the North Pole?

These and a thousand other questions can be answered by Frank S. Wyle of El Segundo, Calif., with the help of specialists at Wyle Laboratories and Wyle Research Corporation. The groups, founded four years ago, can make any kind of weather or environment in the world to test all kinds of products. An okay from them carries with it Armed Forces acceptance for most types of components without additional field testing.

Independent laboratories like the Wyle organization are playing an increasingly important role in aircraft and missile development. A contractor turns to them so that he can concentrate on production and design development. Otherwise he may find himself in the position of having spent so much effort on qualifying current items, that when the demand arises for new types of components, they are not ready.

A second advantage of the in-

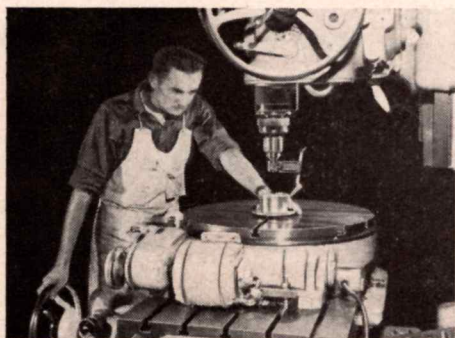
Impact tests are recorded with 5-116 Oscillograph and Statham accelerometer

POWER...FOR TRANSONIC GUNNERY TRAINING!

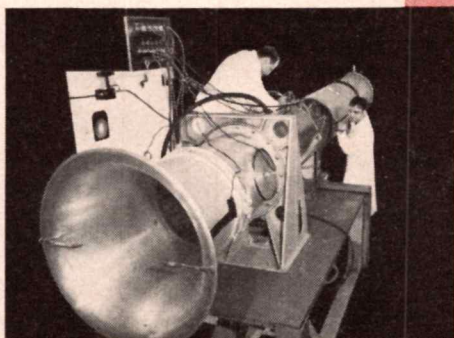
Fairchild's J44 Turbojet, designed for powering remotely controlled drones and missiles, is in production for the U. S. Navy to provide much-needed gunnery training with transonic targets for the major military services.

The J44 is a low-cost, easy to maintain engine capable of repeated flights and long-service-life. Its rugged construction withstands repeated launchings from ground cradles, shipboard catapults or from mother planes in the air.

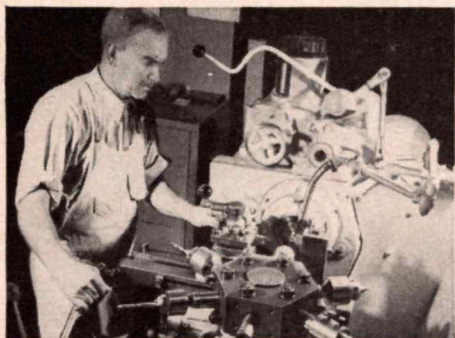
Creative thinking and advanced design techniques incorporated in the J44 and other turbojets, as well as new type propulsion systems for underwater ordnance, keep the Fairchild Engine Division in the forefront of powerplant development.



Efficient production design of the J44 Turbojet requires only standard tooling—means economical production.



In actual service the J44 has demonstrated performance far in excess of original engineered service life.



Fairchild Engine specialists have years of experience in powerplant design and manufacturing.



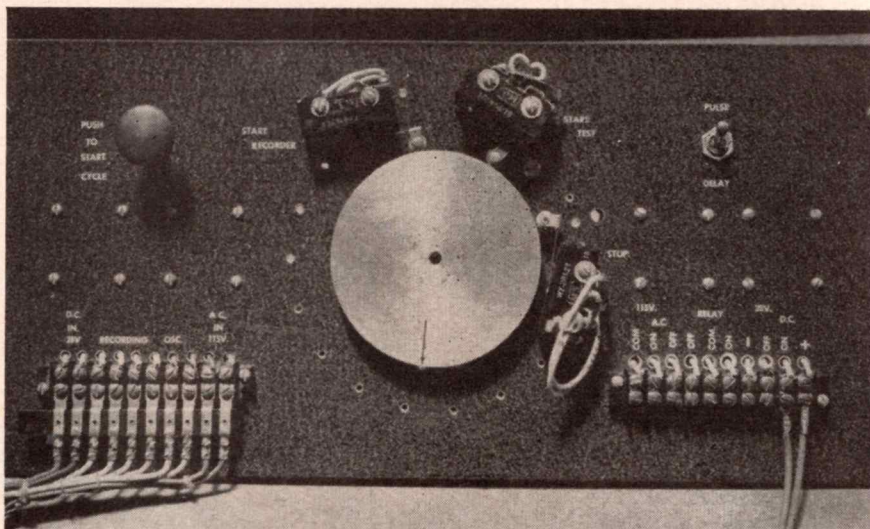
The simplicity of the J44 construction means easy field maintenance using only standard equipment.

**Including AL-FIN, the Fairchild patented process for the molecular bonding of aluminum and magnesium to steel, cast iron, nickel or titanium.*

Fairchild J44 Turbojets have completed hundreds of operational flights in swept-wing Ryan Firebee target drones.



Other Divisions: Aircraft Division, Hagerstown, Md. • American Helicopter Division, Manhattan Beach, Calif. • Guided Missiles Division, Wyandanch, N. Y. • Kinetics Division, New York, N. Y. • Speed Control Division, St. Augustine, Fla. • Stratos Division, Bay Shore, N. Y.



Programmer for oscillograph insures proper data recording

dependent testing laboratory stems from some basic differences in philosophies and practices between a research and a qualification-testing organization. In a development company's research lab, everything should be done to make each experimental design fail, for only in this way will the basic weakness in the design be revealed.

In qualification testing, on the other hand, the primary responsibility is to determine in a fast and economical manner whether a sample component representative of a new production run will meet minimum specification requirements. The two philosophies do not work well together in a single laboratory.

Wyle Laboratories and Wyle Research Corporation specialize in qualification testing. Continuing policy is one of steady expansion of heavy qualification test facilities of a type that the average component vendor would find economically unfeasible. These include high-flow fuel systems, a high-flow, high-temperature air system, walk-in cold chambers, electronic benches wired for simultaneous testing of heavy components, and complex instrumentation including high-speed recording systems. Such extensive facilities can be justified only by an independent laboratory, where they are used continually on hundreds of equipment manufacturers' items.

Figuring importantly in many tests at Wyle Laboratories is a Consolidated Engineering Corp. 5-116 Recording Oscillograph and a

Coupling System D, which includes linear/integrating and carrier amplifiers. Together with a wide range of pressure, velocity, strain and acceleration pickups, these two major instruments permanently record test results and make it possible to correlate various operating characteristics with each other, with time, and with ambient

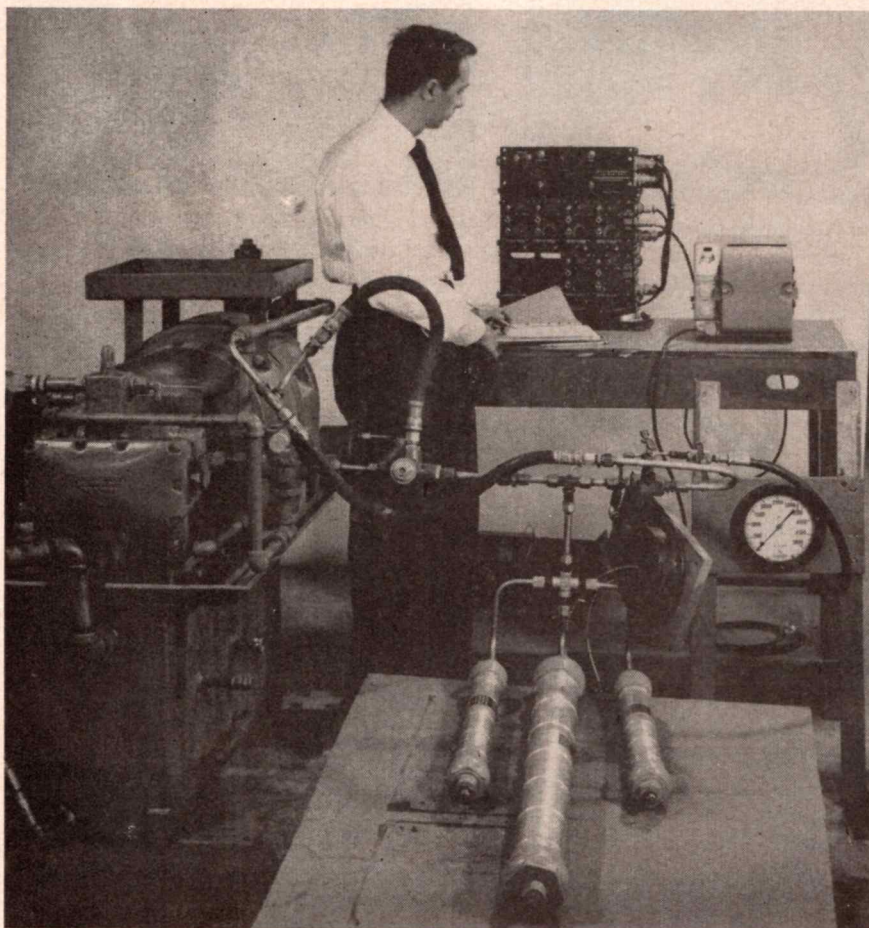
conditions. They are an important part of every test where high-speed or transient phenomena are encountered.

Wyle is also equipped for application of vibration at both low and high temperatures in accordance with Specifications MIL-E-5272. In addition to current equipment, an additional vibrator to handle loads of up to 3000 lb. at frequencies as high as 2500 cps is under construction. Its capacity will be among the largest in the country, and it will be an important forward step in testing components for rocket aircraft and missiles.

Present vibration test equipment includes one electro-dynamic unit of approximately 800 lb. force capacity operating within a frequency range of 2 to 2500 cps. At low frequencies it has a total displacement of approximately one in.

Calibration of both displacements and velocities generated by the vibrator is made with a Consolidated Engineering 4-102A self-generating velocity pickup attached to the mounting platform, its sen-

Set-up at Wyle lab for impulse testing of hydraulic piston-type accumulators



NEW AiRESEARCH GAS TURBINE COMPRESSOR

Starts Jet Engines in Seconds



This new AiResearch gas turbine compressor (GTC85) will start the latest 10,000 lb. thrust jet engines within seconds.

Mounted on a Jeep for easy transport, it is shown starting one of the latest U. S. interceptors, the Convair F-102.

The AiResearch GTC85 has fully automatic controls. Its two stage compressor is *surge free*—even from full

bleed to no bleed. It can be restarted instantly after switch-off in case of afterfire in the main engine. It has proven itself at high altitude, in desert heat of 130° F., and in Arctic temperature of -65° F.

In addition to the starting power, the AiResearch GTC85 can supply power and heat for ground refrigeration, ice removal, cabin preheat and for ground testing of ram air turbines.

The GTC85 weighs less than 200 lbs.

Hundreds of AiResearch gas turbine compressors are now operating in the field. In the last ten years, AiResearch has accumulated more operational, engineering, production and testing experience in small gas turbine compressors than any other manufacturer. Model GTC85 reflects the improvements and increased reliability of this long production and service period.



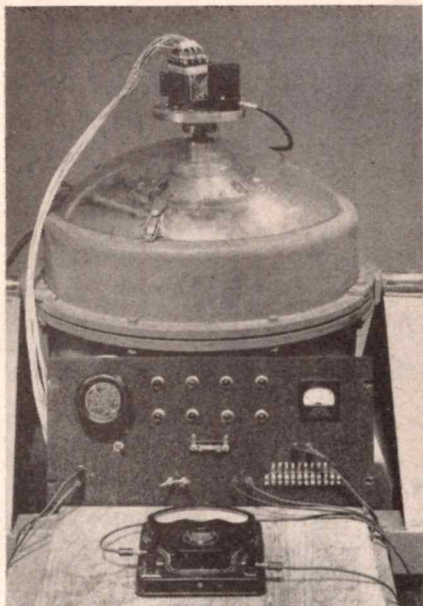
THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Designers and manufacturers of aircraft components: REFRIGERATION SYSTEMS • PNEUMATIC VALVES AND CONTROLS • TEMPERATURE CONTROLS

CABIN AIR COMPRESSORS • TURBINE MOTORS • GAS TURBINE ENGINES • CABIN PRESSURE CONTROLS • HEAT TRANSFER EQUIPMENT • ELECTRO-MECHANICAL EQUIPMENT • ELECTRONIC COMPUTERS AND CONTROLS



Vibration test unit

sitive axis parallel to the direction of table movement. Output is fed to a special amplifier allowing direct reading of both displacement and acceleration.

High-flying planes and missiles have made the low-temperature test facilities at Wyle of prime importance. Heart of the system is a 6000-lb. capacity liquid carbon

dioxide tank from which heavily insulated recirculating piping goes to almost every corner of the 12,000 sq. ft. laboratory area. The entire system is maintained at approximately 275 psi. Cold chambers range from a 7x7x14 ft. walk-in to many smaller chambers, each about 8 cu. ft. By proper valving of the CO₂ lines and release of the liquid refrigerant, temperature inside a 10 cu. ft. chamber can be dropped from room level to minus 100 deg. F. in about 30 sec. Liquid is bled from the system through a solenoid valve in an expansion valve directly in the cold chamber. The system makes such problems as low-temperature vibration tests relatively simple, because the article being vibrated can be surrounded by almost any type of enclosure, inside of which the temperature can be dropped to minus 65 deg. F. or lower and held very accurately by thermostatically controlled release of liquid CO₂.

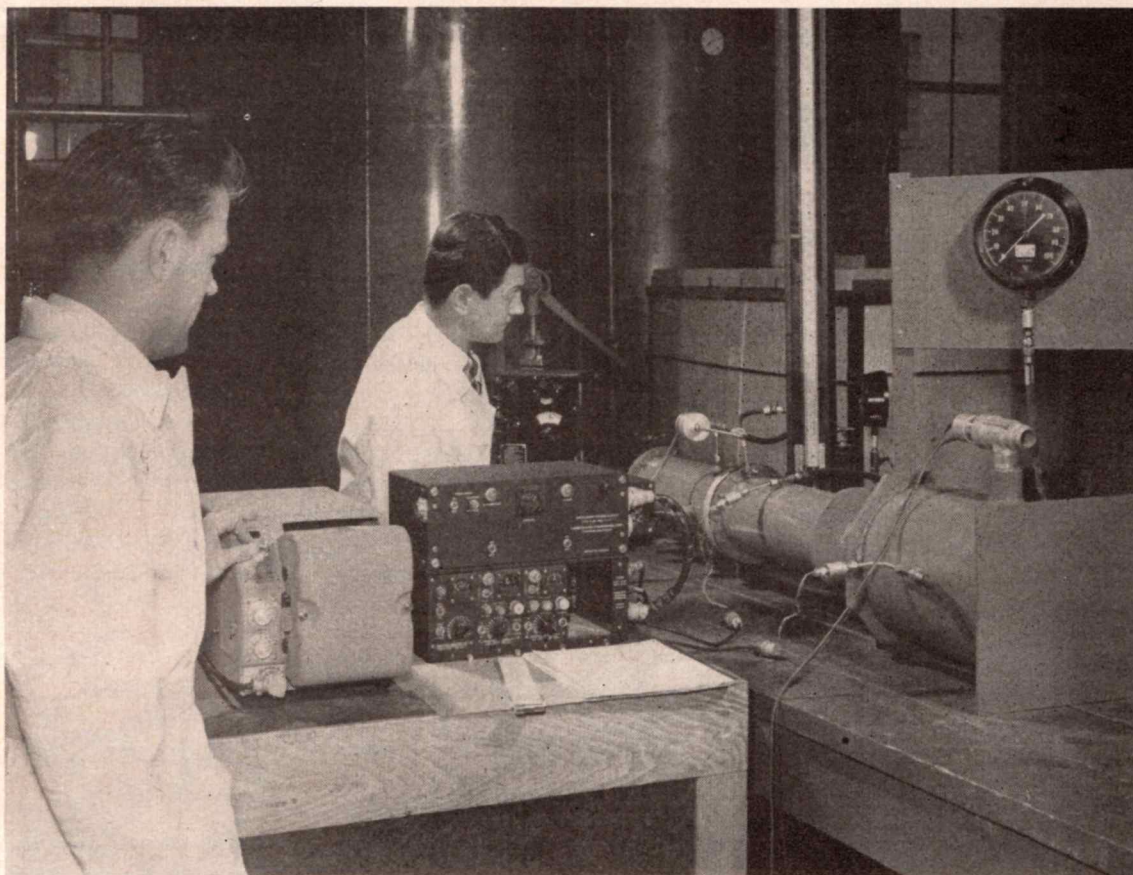
When the item undergoing test cannot tolerate a CO₂ atmosphere, heat exchangers are used. For example, in the large walk-in cold chamber liquid CO₂ is used to

lower temperature of a tank of Stoddard Solvent, which is then pumped through the interior exchanger. Thermostatic control of the liquid at slightly below the desired test-chamber temperature enables levels to be accumulated and maintained very accurately, without the overshoot of dry-ice sublimation systems.

The cold chambers are not merely super-refrigerators, however, for manufacturers and government agencies need to know not only whether a component operates but also how it operates in extreme cold. For example, to evaluate the starting characteristics of electric motors at very low temperatures, several interrelated phenomena must be measured. How much torque is developed? What is the current consumption at the instant of starting and at normal running speeds? What is the temperature rise? What is the time lag in reaching full speed? Inside the cold chamber answers to these questions are converted to electrical signals by suitable transducers and are recorded simultaneously on the nearby oscillograph.

END

High-flow air tests are made with this unit at temperatures up to 1000 degrees



How Heat-Treatment Affects Alloy Steels

This is the fourth of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

There are in general five different forms of heat-treatment used with hot-rolled alloy steel. These treatments modify the mechanical properties of the steel to suit the end use. Basically, heat-treating may be defined as an operation or series of operations involving the heating and cooling of steel in the solid state to develop the required properties.

The five forms of treatment mentioned above, as applied to constructional alloy steels, are discussed in the following paragraphs:

(1) QUENCHING AND TEMPERING usually consists of three successive operations: (a) heating the steel above the critical range, so that it approaches a uniform solid solution; (b) hardening the steel by quenching it in oil or water; and (c) tempering the steel by reheating it to a point below the critical range in order to effect the proper combination of strength and ductility.

(2) NORMALIZING is a form of treatment in which the steel is heated to a predetermined temperature above the critical range, after which it is cooled slowly to below that range in still air. The purpose of normalizing is to promote uniformity of structure and to alter mechanical properties.

(3) ANNEALING consists of heating the steel to a point at or near the critical range, then cooling at a predetermined rate. Annealing is used to develop softness in steel, to improve machinability, to reduce stresses, to improve or restore ductility, and to modify other properties.

(4) SPHEROIDIZE-ANNEALING is the prolonged heating of steel at an appropriate temperature, followed by slow cooling to produce a globular condition of the carbide. This treatment produces a structure which may be desirable for machining, cold-forming or cold-drawing, or for the effect it will have on subsequent heat-treatment.

(5) STRESS-RELIEVING is the process of reducing internal stresses by heating the steel to a temperature below the critical range and holding for a time interval sufficient to equalize the temperature throughout the piece. The object of this treatment is to restore the elastic properties of the steel, or to reduce stresses that may have been induced by machining, cold-working, or welding.

Bethlehem metallurgists have had long experience in all methods of heat-treating. They understand the possibilities and limitations of each method with respect to various alloy steels. These men will be glad to give advice or help you with any problems concerning heat-treatment. Always feel free to ask for their services.

And call on Bethlehem, too, for the full range of AISI standard alloy steels, as well as special-analysis steels and all carbon grades. We can meet your needs promptly.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM *ALLOY* STEELS





Unloading the core drying oven at AiResearch steel foundry

A study of the factors involved
in the fabrication of your own
castings vs outside purchasing

By FRANK WARGA
AiResearch Manufacturing Company

Establishing A New Foundry

Induction melting furnace after adding alloy for stainless steel pour



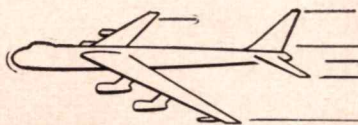
TO get first-quality casting at reasonable prices, AiResearch Manufacturing Company has twice been compelled to acquire complete foundry facilities.

Our initial foundry (which is still in operation) was established in 1946 to produce aluminum sand castings. Our second foundry began producing ferrous castings on Dec. 16, 1952.

It was our belief in establishing the latter unit that our experience in casting non-ferrous alloys would be of much practical value. This proved to be slightly optimistic. We did enjoy some of the advantages of the proverbial tyro who—being unaware of what could not be done—went blindly ahead and accomplished the impossible.

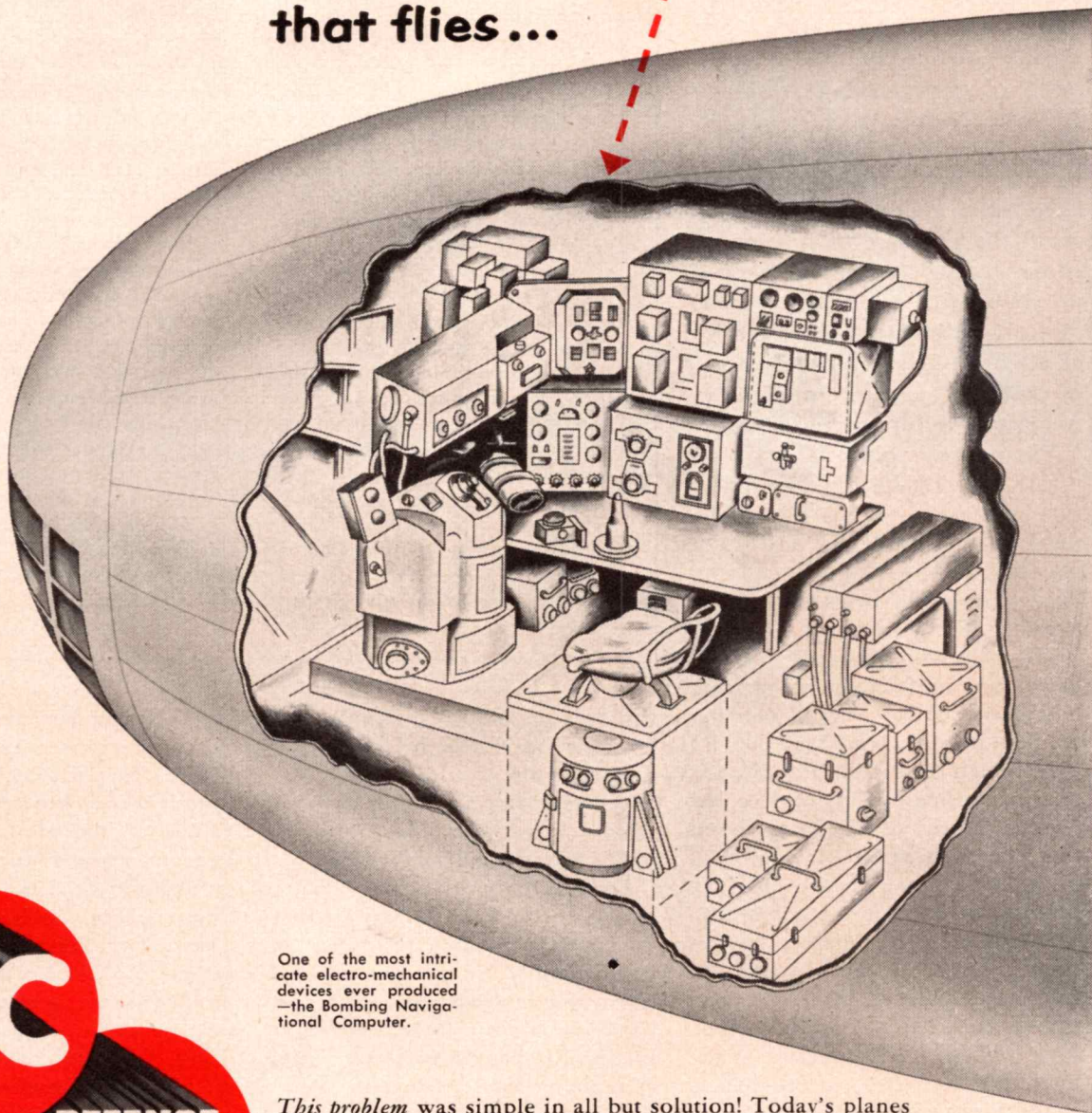
Our ferrous foundry in 11 months has produced 33,000 acceptable castings from a total tonnage poured of approximately 155,093 lb. While these statistics do not by any chance represent what we think should (and will) be our optimum level of productivity, they do indicate first-year operations that have been pleasingly profitable.

Most of our ferrous casting work involves the production of relatively small, thin-walled articles



SOLVED:

the problem of the
"thinking machine"
that flies...



One of the most intricate electro-mechanical devices ever produced—the Bombing Navigational Computer.



AC SPARK PLUG DIVISION
GENERAL MOTORS CORPORATION
FLINT, MICHIGAN

This problem was simple in all but solution! Today's planes and plans have outgrown the scope of human minds. A device had to be developed to solve complex aerial navigation and bombing problems with superhuman speed and accuracy. Yet, this device must still be light enough to fly. *The answer* is now coming off the production lines of AC's Milwaukee plant—the Bombing Navigational Computer. Through miles of complex wiring, electronics now can home planes in on targets with unerring skill.

AC's contribution—in the three fields of research, development and production—is another example of know-how in action. AC's exceptional engineering staff and unique facilities are as close as your phone. Why not consult AC?

DEFENSE PRODUCTS of High Quality at Low Cost DELIVERED ON TIME

NOVEMBER 1954

with weights ranging from 2 oz. to 7 lb. They comprise Armco 17-4 (precipitation hardening), Ni-Resist (types 1 and 2), and virtually all stainless steel alloys.

Our ultimate objective in producing these casts is to provide the company with components that will be so perfect in the "as-cast" condition that they will require no machining. "As-cast" components to date have been accurate within 0.10 in. tolerances and consistently capable of meeting the requirements of government specifications for X-ray testing.

In the procurement of equipment for our ferrous foundry, we have been especially careful to avoid the purchase of heating facilities that could not be operated in conformity with local "smog control" ordinances—enforcement of which has led to the bankruptcy of several foundries in the Los Angeles area during recent years.

We are now using:

(A) Two 150-lb. capacity induction furnaces (one is a standby unit) in melting Armco and stainless steel alloys (with pouring temperatures in the neighborhood of 3000 deg. F.).

(B) A 450-lb. capacity Detroit Rocking Arc furnace in melting Ni-Resist alloys (with pouring temperatures of about 2850 deg. F.)

Although a new pattern shop is now being operated as part of our ferrous foundry, we have found that the same types of wood and metal patterns that are used to produce molds for casting aluminum will meet our present ferrous foundry requirements. In fact, we frequently balance the work load in our two pattern shops by having some masters for aluminum made by our nonferrous pattern-makers—and vice versa.

In the fabrication of cores, we are now making satisfactory use of extra-fine core sands and oil-type binding media. We are hoping that a current series of tests will get us better results by using synthetic core binders. A 6000 lb. capacity oven is used in baking our cores.

We have been tempted to make use of investment molds in producing a number of ferrous casts, but experience has shown that any ad-

FIFTY-YEAR CYCLE

By GROVER LOENING

The first Wright plane was launched while balanced on a truck riding monorail track. This system saved the expense of fixing a smooth field and saved landing gear weight. In the many 1905 flights particularly, the Wrights introduced the catapult to assist on the take-offs, and then eventually went to wheels. A long and painful landing gear development followed. Finally today, our concepts are beginning to return to the original Wright conception, with the use of assistance in take-off by either catapult or rocket jato assist. Even additional small jet engines are now being contemplated to give an assist in take-off, and when reversed to give a retarding influence on landing. We see at least a more determined struggle going on in the aviation engineering development to compromise the requirement of the highest possible speed for utility with the lowest speed for practicality.

History shows there is no question about the utility of high speed in aircraft. There is nothing more useless than a slow airplane. Once in the air, all the

economics of air transport, all the characteristics so needed by military, all the practical usefulness so needed by the individual owner, all bring success to aircraft development only if the item of higher speed is included. And yet these eminently promising prospects for great future development are hampered initially by the take-off and landing limitations that our present day airplanes require. This is dawning upon the brilliant engineers in the industry and we will see shortly—in fact are already seeing—a great deal more attention given to assisted take-offs and catapults.

Now several advanced designers are beginning to think in terms of fast aircraft of much lighter weight (because they carry no landing gear to speak of) that will take off on a field using a catapult or a powered launching car and will land on simple skis that will have no extensive roll and no need for brakes. And when we do this, it is interesting to see the 50-year cycle reverse itself. Fifty years later we return to the original Wright concept.

vantages gained in quality would be greatly exceeded by higher production costs.

We now use shell and dry-sand molds exclusively. Most of these molds are manually fabricated.

For our particular purposes, we feel that the cost of shell molds (made with phenolic resins) can be justified only by improvements in the quality of stainless steel castings. We are currently hopeful for further improvements by using ceramic molds.

Silicone release agents are being used to prevent adhesion of mold and pattern materials. Casein-type adhesives are being used to assemble both shell and dry-sand molds to minimize the quantities of alloys that are wasted when casts are made.

The molds are manually filled by ladles which are preheated to maintain proper pouring temperatures.

Grinding, shot-peening, and

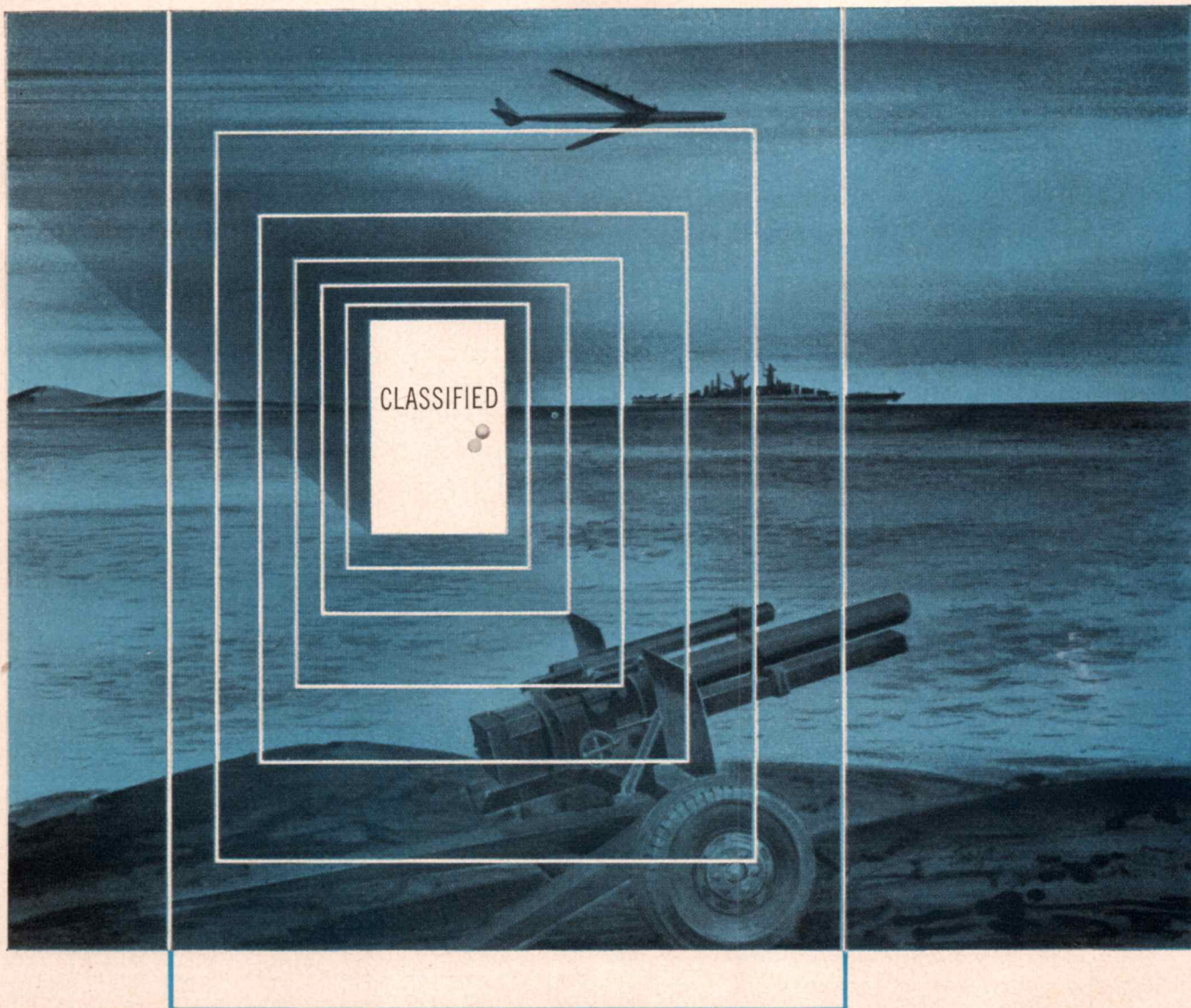
sand-blasting facilities are used to clean cast-metal components. Then, before the parts leave the ferrous foundry, they are annealed.

One of the most serious problems in ferrous foundry work is the matter of gating. We are convinced that the only satisfactory way to gate a mold for ferrous castings is to use a liberal amount of common sense in preparing for each new project.

We have avoided most of the metallurgical headaches associated with ferrous casting operations by purchasing pre-alloyed metals, and by making constant use of a rapid carbon determinator. We are now finding it both economical and practical to prepare our own alloys for experimental work and small-scale production operations.

Barring some unpredictable calamity, our ferrous foundry will be operating at the peak of its production capacity by the end of 1954.

END



FOCUS ON FLEXIBILITY

Behind the guarded doors at Crosley, you find...

the tools, skills and staff to meet rigid government requirements for research, engineering, development and production;

a reliable source for Military electronics systems, electro-mechanical and mechanical equipments and components, ranging from fuzes to missiles and radar units;

immediate response to Sub-contracts, as well as major Prime contracts;

Crosley facilities focused on flexibility!

"Right and On Time," an illustrated brochure describing Crosley facilities for Military production, is available to Procurement Agencies and Defense Contractors. Be sure to write for your copy today, on your business letterhead.

CROSLEY
CINCINNATI 15, OHIO

GOVERNMENT PRODUCTS DIVISION



ENGINEERS: Opportunities are open to highly skilled engineers at Crosley where long-range research and development contracts in electronics, electro-mechanical devices and fire control systems are constantly expanding. Contact our Director of Engineering.

Paint Spray System Brings Savings

By JAMES JOSEPH

Northrop develops a new, labor-saving use for flow coating

FLOW-COATING—continuous, automatic paint spraying—is in itself a fairly recent methods-development.

Principally it's been used to apply average to heavy-viscosity finishes—enamels, for example. Now Northrop Aircraft, Inc., announces a new use. After a year's study and practice, the aircrafter has adapted flow-coating to very light viscosity finishes—specifically, to priming aluminum and aluminum alloys with zinc chromate.

Flow-coating zinc chromate, as opposed to traditional hand-spray or dip methods, has resulted in sizeable savings. Now a single automatic spray booth can prime twice as many parts as operators hand-spraying in a water-wash booth; labor has been reduced; control of finish-thickness can be held to closer tolerances; one pass through a flow-coat booth finishes such light metals as aluminum extrusions and stampings; handling time is reduced; less primer is lost to evaporation and exhaust; and since only about 140 gal. of thinned chromate circulates the flow-coating booth, chances of waste thru contamination are reduced.

Parts under discussion here are interior-aircraft components. They get but one coating—the zinc chromate primer. The primer, Northrop Seal No. 75 thinned with Sherwin Williams Flo-Coat Primer Reducer, is a corrosion inhibitor for aluminum and aluminum alloys. The same primer works satisfactorily on other types of light metals (titanium and magnesium), either alone or with a top coat. Applied to metals other than aluminum, the primer's function is that of insulating rather than corrosion inhibiting.

There are a number of application criticals: (1) nozzle pressure; (2) ratio of thinner to primer;

(3) pattern and fineness of the spray. These determine: (1) thickness of wet coating, thus dry film thickness; (2) amount of thinner lost up the booth's exhaust stack; (3) amount of primer and thinner added during any production run.

Particularly critical is nozzle pressure. Control factors are: (1) pump pressure; (2) diameter of spray-head orifices; (3) viscosity of the mixed and diluted primer.

"Pressure," says Northrop's K. B. Niles, the process engineer who developed the Northrop-formula zinc chromate, "is exceedingly critical. Raise the pressure 1 to 2 psi and you lose two to three times as much solvent (thinner) up the stack. This, because of the thinner's high boiling point."

Thickness of a single dried primer coat is controlled to between 0.25 and 0.35 mil (0.00025-0.00035 in.). Total thickness of zinc chromate primer on surfaces

to be topcoated must not, according to both Northrop and Air Force specs, exceed 0.7 mil (.0007-in.).

The greatest variable, of course, is the dilute solution of primer—since loss of thinner is relatively large over short-runs.

Northrop, for example, assigns an operator to its spray booth. His function is to check solution dilution—and to add thinner or primer as needed.

Usually, 1-2 gal. of thinner are added to the operating tank every 15 min. Average hourly usage: 6-7 gal. of thinner. By comparison, only a few gallons of primer are added during an 8-hr. production run. Primer is much more expensive than thinner.

Says Niles, "We lose very little—practically no—primer up the booth's stack, although thinner loss through exhaust and evaporation is high."

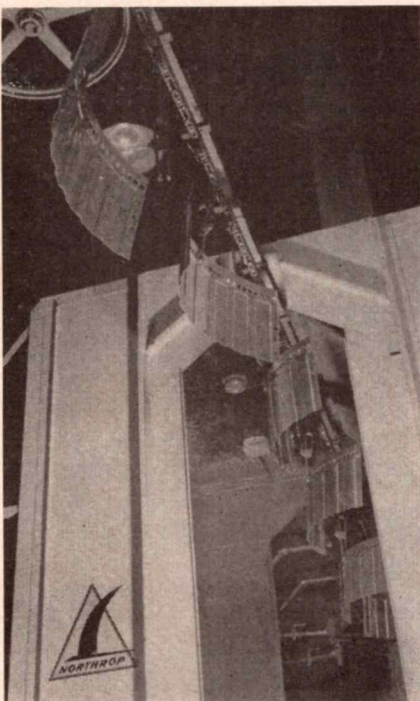
The relatively low loss of expensive primer compares to the average 55-gal. drum of "water wash sludge"—water impregnated with pigments—collected daily from some Northrop water-wash booths.

As for pressure and pattern control, nozzles are supplied via a 3-in. Viking Model LL-152 paint pump, capacity 100 gpm at 10-15 psi and driven by a 5-hp explosion proof motor. Another motor-driven pump (1½-in. Viking Model ZK, cap. 20 gpm at 10-15 psi powered by a 1½-hp motor) circulates primer from its storage tank to the operating tank when make-up primer is needed.

Flow-coating sees Northrop process an average 600 parts an hour—upwards, on occasion—to 1000. Labor has been reduced to loading-unloading and to a single operator assigned the booth. Northrop reports far better dried film control and is planning new installations.

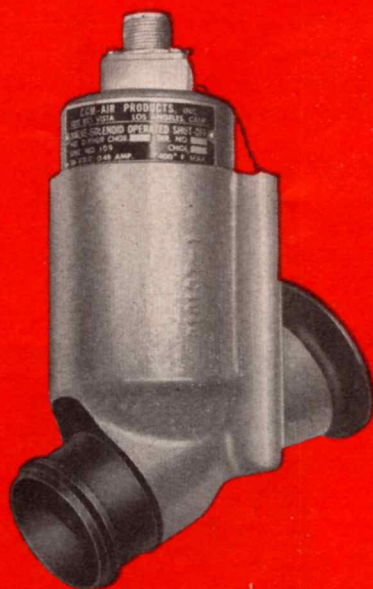
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Flow coater in full operation. Note method used to attach parts to conveyor line



NO EXTERNAL BLEED

HOT AIR SHUTOFF VALVE #109

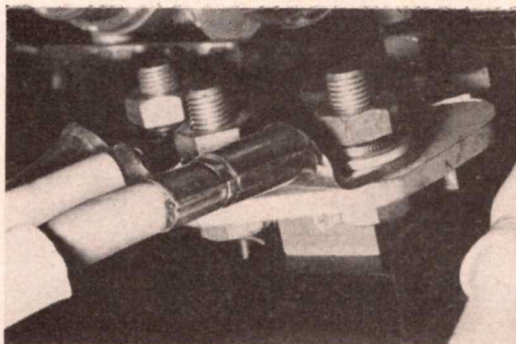


Solenoid Pilot Operated
EXTREMELY LOW PRESSURE DROP
Current drain 0.5 amp. at 24 VDC
Continuous duty
OPERATING PRESSURE 4 TO 125 PSIG
Weight 1.5 lbs. for 1.5" tube size
Max. leakage 0.25 lbs./min. at 125 PSIG
Air temp. to +400° F.

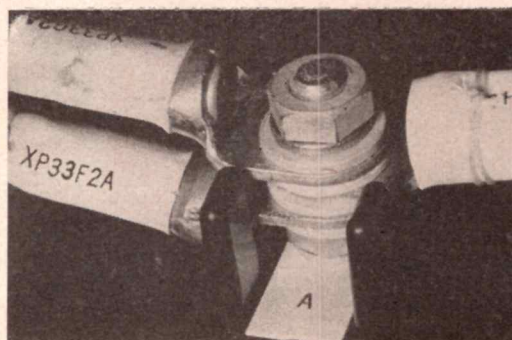
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Shunt installation using aluminum washers



Terminal installation, aluminum termination at left

Aluminum Cartridge Termination

By R. B. DONAHUE

Aircraft Standards Supervisor, Chance Vought Aircraft, Inc.

New American Marine Product termination technique opens door to even wider use of weight-saving aluminum cable

USE of aluminum wire in Chance Vought F7U-3 has saved approximately 32 lb. per airplane. At the present stage in the trend toward smaller, more compact, faster and lighter ships, use of aluminum wire is generally confined to cables in the No. 6 thru 4/0 sizes. Use on smaller wires is generally restricted due to heat involved or the poor flexing characteristics of aluminum wire.

Although aluminum wire has always been difficult to terminate successfully because of the high creep rate, rapid oxide growth, and anodic action, recent investigations at Chance Vought have revealed inadequacies in the accepted standard termination practice due to high ambient temperatures encountered in localized areas of the F7U-3 as a result of equipment operation.

The results of these investigations not only point to refined aluminum termination techniques and the successful use of aluminum wire in the F7U-3, but also are encouraging for a greater use of weight-saving aluminum wire in the future.

In attacking the problem, one terminal manufacturer, Aircraft-

Marine Products, Inc., in a report from J. J. Redslob, Supervisor of Project Engineering, advanced data based on 10 years research, which offered conclusions considered especially worthy of note. The unreliability of aluminum terminations was attributed to the following basic characteristic of aluminum:

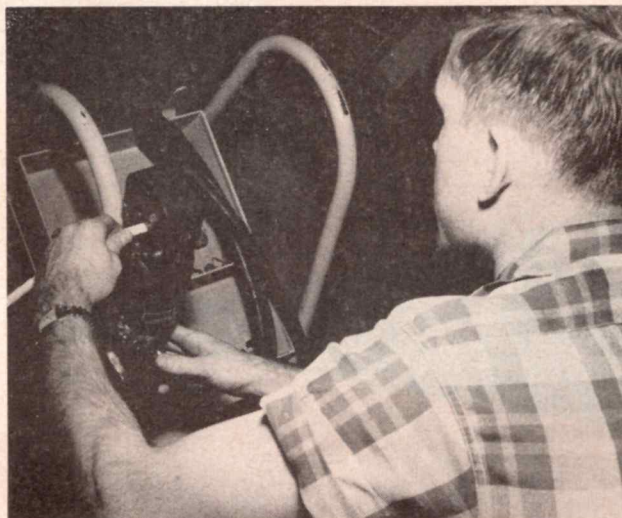
1. Aluminum oxide.
2. Creep rate.
3. Position in galvanic series.
4. Coefficient of thermal expansion.

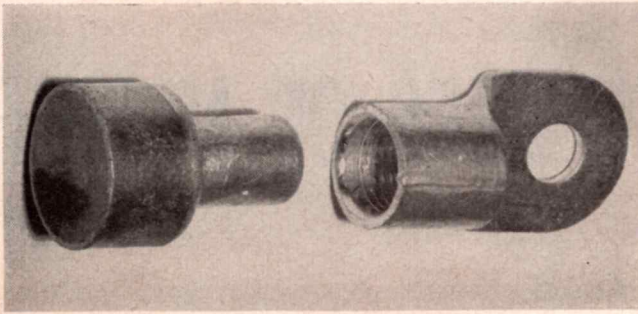
5. Low resistance of aluminum wire strands to breakage under continued flexing.

Aircraft Marine Products also reported the production of a terminal which overcomes the difficulties.

The highly resistant oxide coating forms to a definite thickness on aluminum cable as soon as it is exposed to air. Heat generated under rated current increases this thickness, thus increasing the resistance which increases the heat until failure occurs. A successful

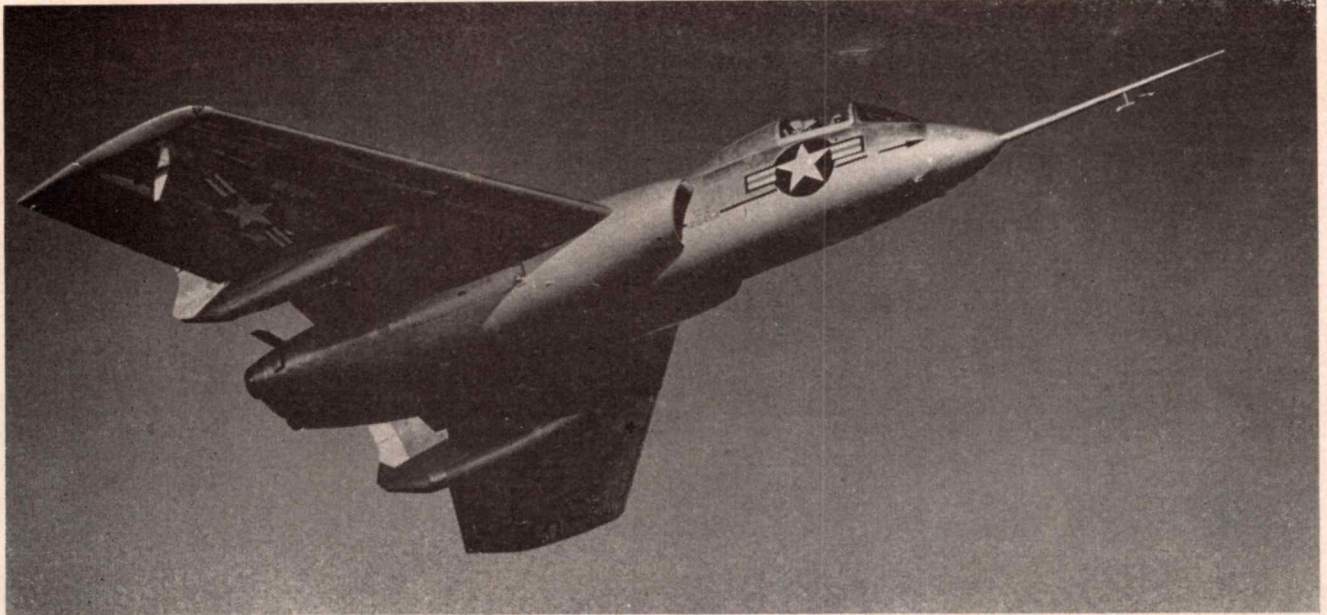
Portable pneumatic-hydraulic tool crimps new cartridge-type aluminum terminal





Cartridge of AMP "Copalum" terminal. End is sealed with transparent cap, color coded for each range

Weight saving aluminum wires and cables are used extensively on Chance Vought Cutlass



termination must destroy this oxide coating and prevent its reformation. The accepted approach to this objective has been to fill the terminal barrel with a grease-like material containing a powdered metal in suspension. At the time of crimping the terminal the metal acts as an abrasive to expose bare spots of aluminum through the oxide coating. The grease-like substance prevents reoxidation.

The new cartridge style AMP terminal incorporates the following design characteristics to overcome oxidation:

1. An inhibitor of nickel particles suspended in vaseline.

2. Enclosed thimble which retains the basic characteristics of the inhibitor. The cartridge is pre-filled and sealed at the back end with a plastic cap to prevent the loss of inhibitor in storage or handling. When ready to perform a termination, the plastic cap is removed and the stripped wire is inserted into the cartridge. The conductor is forced to penetrate the inhibitor filled cartridge which

is closed at the front end. Acting as a plunger in a cylinder, the wires force the inhibitor among and between the strands. This type of action gives better results in comparison to just brushing the inhibitor on the wire, or dipping the conductor in a container filled with compound.

3. Proper plating of the terminal,
 - a. Primary plate of zinc by immersion
 - b. Secondary copper flash for bonding of the final plate
 - c. Final plate, tin electroplated.

The relative high creep rate of aluminum cable necessitates a relatively lower stress which could result in a poor electrical connection. Therefore, this low residual contact pressure must be compensated by an effective contact area as large as possible. The confined type crimp is superior to the indent type in this respect.

AMP terminals overcome the relative high creep rate of aluminum by having a "confined" crimp producing an enlarged crimp area,

with controlled reduction of cross sectional area. This "confined" crimp increases to a maximum the contact areas between the strands and cleans them all at the same time. Its symmetrical appearance tends to deform all the wires uniformly. This eliminates the danger of hot spots in the crimp as each strand carries its share of the current. -

The optimum contact surface of the terminal tongue was determined by using the largest size terminal with the largest stud hole, and determining the heat dissipating and contact area needed.

The protrusion of the cartridge from the back of the terminal lug serves primarily as an insulation grip to increase the strength of the wire at its most vulnerable point. It also helps to seal in the inhibitor, preventing a change in its characteristics. The material for the terminal (3S aluminum sheet) was chosen to provide as hard a material as possible for the tongue and still soft enough to be extruded by crimping.



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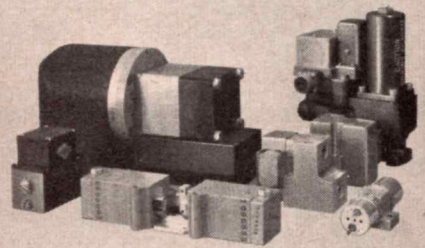
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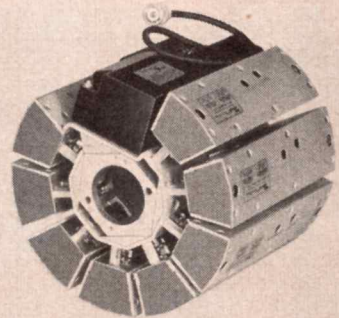
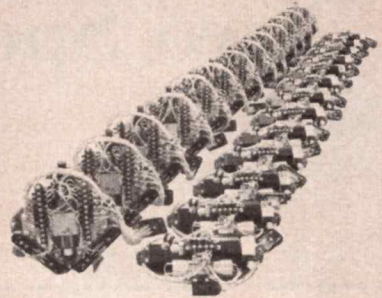
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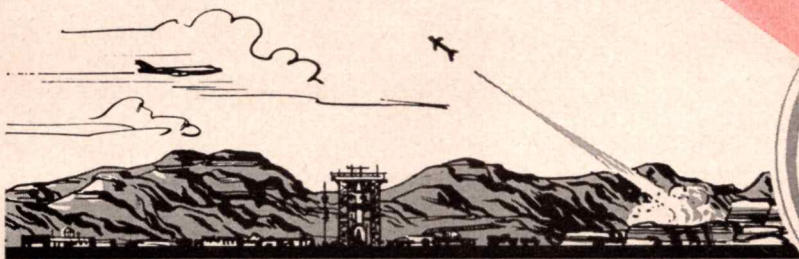
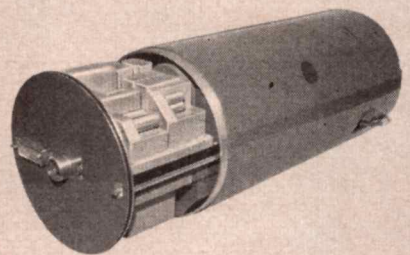
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NOVEMBER 1954

Questions and answers to some of the most important engineering questions in today's complicated jet engines

Two Spool Aircraft Engines

By JOHN MITCHELL STEPHENSON

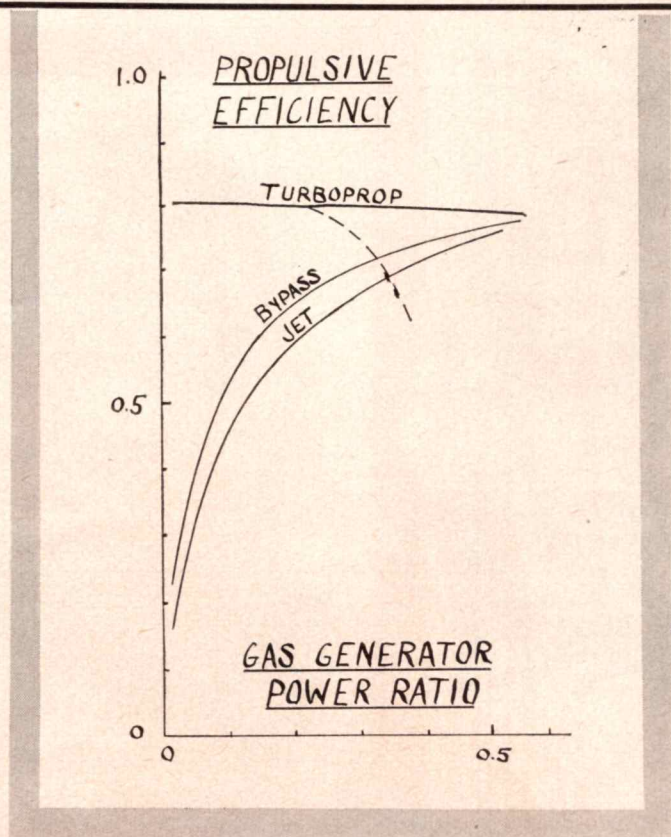


Fig. 1 Variation of propulsive efficiency

THIRTEEN years ago, with the advent of gas turbine jet engines, they were generally supposed to be heralding a new era, not only of speed, but also of simplicity. But now that their design and behavior is better understood,

they are growing vastly more complicated and costly. They may, for example, have two independent coaxial shafts—or two jet nozzles, one hot and one cold—or may have a propeller geared to one of the compressor shafts, or to a

separate shaft driven by a gas turbine.

Are the continuing complications worth while?

To answer this major design question, a number of others must be raised and answered:

What is the most important criterion for a good aircraft engine?

Analysis show that for almost all aircraft duties, except for very short range interception, the most desirable feature of any engine is a high efficiency, or low fuel consumption. To achieve this, it appears worth while up to a certain point making an engine heavier and more costly.

Note that the thrust, by itself, is no measure of the merit of a jet engine. Much publicity is given in the non-technical press to various jets, including Russian, which are claimed from time to time as "the most powerful in the world."

This sort of claim has little value, because one of the characteristics of turbojet and rocket engines is that any desired amount of thrust can be obtained simply by making an engine big enough. An engine's true worth can be

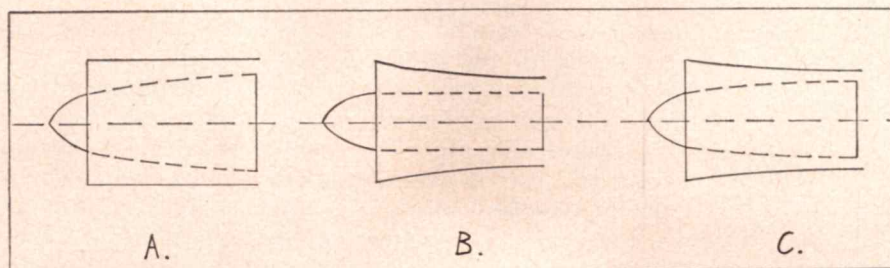


Fig. 2. An infinite number of curves could be used for the internal walls of a compressor. Most common are those with constant outside radius (A), constant inside radius (B), constant means radius (C)

measured only on one assumption: it must have the right amount of power for the job in hand.

What does the efficiency depend on?

To measure engine efficiency, split the engine into the two basic components:

1. A gas generator, which converts the chemical energy of the fuel burnt into the mechanical (i.e. pressure and kinetic) energy of a stream of hot gas.

2. A propulsive device, which converts this energy into axial kinetic energy, and thence into work done by forward thrust. The device may be either a jet nozzle, or a turbine-driven fan, or a conventional propeller.

The engine efficiency, which is defined as: thrust power/power of fuel burnt can be written as the product of the efficiencies of these two components, which are:

1. gas generator, or *thermal*, efficiency: power added to the airstream by the gas generator/power of fuel burnt.

2. *propulsive* efficiency: thrust power/power added by the gas generator.

So to build an efficient engine, the thermal efficiency must be made as high as possible, and the best type of propulsion must be chosen.

To achieve a high thermal efficiency in a gas turbine gas generator cycle, the separate components—compressor, turbine, and combustor—must all have good efficiencies. Within certain limits, the top temperature of the cycle has little effect, but the pressure ratio must be as high as possible. This last requirement imposes great difficulties on the design of the compressor, as will be seen later.

Propulsive efficiency is easily calculated if a few assumptions are

made. It turns out to depend on two important ratios:

1. The bypass ratio, or ratio of the air mass flow through the propeller or fan to the flow through the gas generator. This ratio is very large for a turboprop engine, around 0.5—1.0 for a bypass, and of course zero for a pure turbojet.

2. The ratio of the gas power entering and leaving the gas generator. The entering power per unit mass flow is simply the kinetic energy, and proportional to the square of the aircraft speed; while the leaving power is proportional to the exhaust temperature, which depends on the temperatures and pressures of the engine cycle.

For given values of these ratios, there is a best division of the available power of an engine between the jet and the fan or propeller. Assuming that an engine is always designed to have this best division, the variation of propulsive efficiency looks something like that shown in Fig. 1.

At high forward speeds the propeller efficiency drops, due to the drag of the shock waves, so that the propulsive efficiency of any given propeller engine actually fol-

lows something like the dotted curve of Fig. 1.

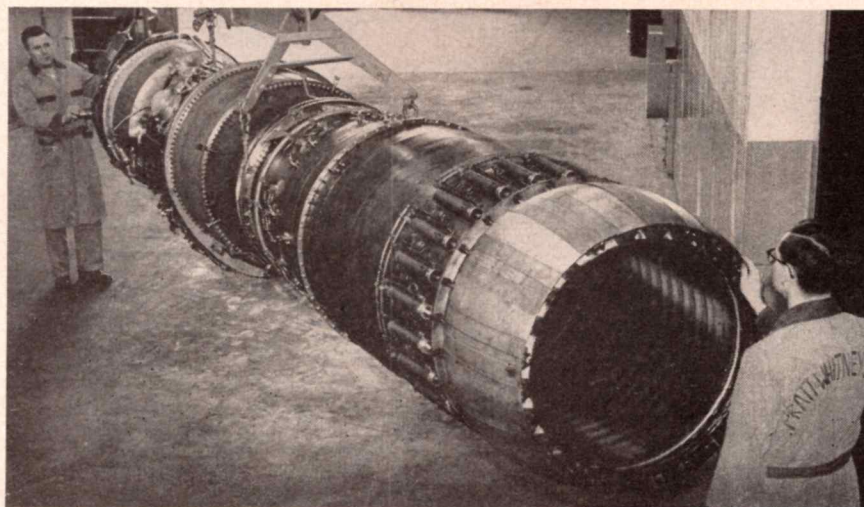
Which is the best type of thrust conversion?

It is clear from Fig. 1 that there is a case for both the bypass and the turboprop, depending on the value of the gas generator power ratio, and on the efficiency of the propeller at high speeds.

However the propulsive advantage of the bypass over the pure turbojet is small, and with present-day components the edge can be almost eliminated by lowering the top temperature of the jet engine so as to raise the power ratio. Both moves—bypassing and temperature reduction—add to the engine size and weight, and it is among these factors, as well as cost and reliability, that the comparison must be made.

Thus it is not possible to say in general which type of propulsion is the “best”, except for very low speeds where a propeller is vastly more efficient. For all other conditions of operation, the best compromise must be found between propulsive efficiency and complication. As stated earlier, it is usually

Pratt & Whitney's J-57 is good example of two-spool application



worth paying a price for efficiency, but only up to a certain point.

How high can we make the pressure ratio?

Perhaps the most important characteristic of a single-shaft compressor, whether of the axial-flow or multi-stage centrifugal type, is that if the design pressure ratio is greater than about six the machine will not run efficiently at lower pressure ratios. What is worse, it is difficult to prevent surging at low speeds, especially during starting or acceleration. This instability has often been sufficiently violent to reduce a compressor to a heap of ripped-out blades in a few seconds.

To obtain single-shaft gas turbine engines with pressure ratios greater than about six, it is necessary to resort to one or more of the following devices, which alter the characteristics of the compressor, or the position of its operating line:

- (1) Blowing off gas from points in the compressor.
- (2) Adjusting the mass flow by varying the turbine or jet nozzle areas.
- (3) Injecting a cooling fluid into the airstream.
- (4) Varying the pitch of some of the blade rows.

Alternatively, the compressor becomes much more stable if it is split into two sections, on inde-

pendent shafts. By making the shafts coaxial, and driven by separate turbines, a very compact and flexible engine is obtained, and it is probable that this "two-spool" layout will become the most popular for high efficiency engines. The improvement in the stability of the compressors can be seen from the positions of the operating lines shown dotted in Fig. 3.

With a two-spool compressor, pressure ratios up to 18 have been obtained. More could probably be achieved before it becomes necessary to use three separate shafts.

How should the pressure ratio be divided between the two spools?

Consider for example, a two-spool jet engine of pressure ratio 10:1, with 14 compressor stages altogether. It is not immediately obvious at which point the compressor should be split—that is, how the two compressor sections should compare in size. However in this case the difficulty is resolved to a great extent by looking at the turbine. For with typical current values of temperatures and component efficiencies this compressor could be driven by a turbine of only 3.2:1 pressure ratio. (The remaining pressure energy is of course converted into propulsive thrust in the jet pipe).

Since the greatest pressure ratio that a turbine stage can handle efficiently is about 1.8, two equal stages would suffice for this engine, one on each shaft. This means that

the compressor stages are divided equally.

There are of course other considerations besides minimizing the number of turbine stages, and hence the turbine weight. In some engines, control problems can be solved by a skillful choice of pressure and temperature ratios, and the resulting flexibility may make it well worth carrying the weight of an extra turbine stage, on either lp or hp shaft.

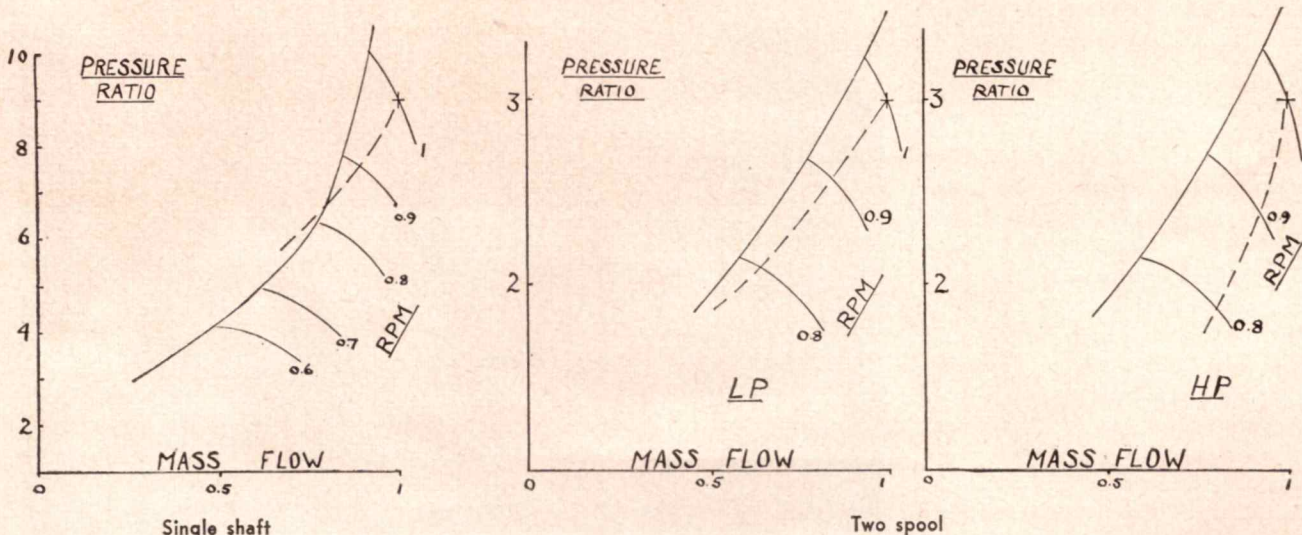
What controls are necessary?

In a gas turbine engine the throttle lever controls the amount of fuel injected, and thus the output power, while the air mass flow, rotational speed, and temperatures must look after themselves. However, three things may go wrong and cause failure, if the engine is accelerated violently:

1. The top temperature may go too high, causing the turbine blades and other parts to over-heat.
2. One or other of the shafts may overspeed.
3. The compressor may surge.

These troubles can be avoided by fitting automatic electronic devices, which measure the speed, temperatures, and pressures, and override the manual throttle so as to limit the acceleration to a safe value. But obviously it is preferable to build engines which are able to accelerate as rapidly as the pilot wishes, and which do not have to carry black boxes full of

Fig. 3 Compressor stability improvement in two spool arrangement can be seen here from the positions of operating lines

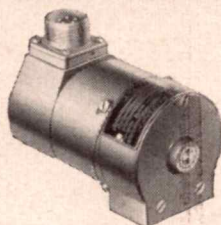




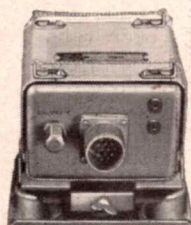
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**used by Northwest
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control systems—which are themselves always liable to fail at the wrong moment.

The most serious trouble—compressor surge, and the associated blades failures—is largely avoided by the use of two spools, as explained above. Much thought is also being given nowadays to the transient performance of engines, so that they will be, as much as possible, inherently self-controlled.

What is the best shape for the compressor duct?

An infinite number of curves could be used for the internal walls of a compressor, but the most common shapes are those with constant outside radius (Fig. 2a), constant inside radius (Fig. 2b), and constant means radius (Fig. 2c).

The first gives a compact engine, if most of the auxiliaries are fitted inside the hub (as in the

J65 Sapphire). On the other hand, a constant inside radius keeps the blades as long as possible at the high pressure end, which helps compressor efficiency when the mass flow is small, as in most turbo-props.

Even with only these three shapes, there are nine combinations possible in a two-spool compressor. The choice is not at all critical, provided that the units are fitted up close to each other without a long duct or corners between them.

What is the penalty in engine weight from using two spools—and is it worth it?

It must be conceded that some weight is added if the compressor-turbine shafts and bearings are duplicated, but the weight penalty in any particular case could only be calculated from a detailed comparison of two otherwise similar designs.

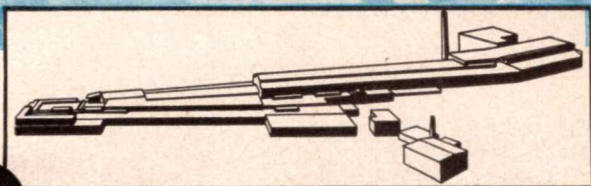
However it is instructive to review the published (sea-level-static) values of thrust-weight ratio and specific fuel consumption of two engines which may be assumed to have comparable techniques of design:

For a 15 percent improvement in fuel consumption, the two-spool engine pays only 10 percent in thrust-weight ratio. Other things being equal, it is more suitable for all aircraft applications where the weight is not 50 percent more important than the efficiency.

As explained at the beginning of this article, the importance of any particular feature of an engine depends entirely on what is to be done by the aircraft to which it is fitted. But for most purposes it pays to make the engine as efficient as possible.

How many two-spool engines have been built?

To date, four companies have been outstanding in the two-spool engine field—Pratt & Whitney and Wright Aeronautical in United States, and Rolls Royce and Bristol, in England. Most intense rivalry is in the pure jet field, where Pratt & Whitney has the J-57 and Wright Bristol's *Olympus*,



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licensed by the U. S. manufacturer as the J-67.

Although the builders of these two-spool jets claim the same thrust (about 10,000 lb), and the same fuel consumption (about 0.77 lb/hr—lb thrust), the two engines represent rather different approaches to the same problem.

Simple calculations show that the aerodynamic efficiency of the J-57's compressor must be rather low—around 80 percent (isentropic) compared with the 87 percent that the J-67 must have achieved to obtain its claimed thrust and consumption. This deduction is encouraged by P. & W.'s admission that control trouble is experienced, so that automatic devices have to be fitted to prevent compressor surging.

As pointed out above, it is precisely to *avoid* the necessity for these devices that two-spooling is resorted to, so that it must be inferred that the J-57's compressor can stand some improvement. And when, after development, 87 percent efficiency is reached, the fuel consumption should fall to better than 0.70.

On the other hand, no notice seems to have been taken of the extra weight involved in getting the consumption as low as possible with the existing components; and it is a remarkable fact that if four compressor stages and one turbine stage were taken off the low pressure shaft, the engine thrust would rise to more than 12,000 lb.! Such a move would put the fuel consumption up to 0.93 or thereabouts, which has clearly not been desired. If more thrust is wanted for short periods, the afterburner can be switched on, to raise the thrust to more than 15,000 lb.

The J-67, by contrast, is not designed to take an afterburner, and it gets as much thrust as possible out of each pound of air swallowed. Thus it represents a compromise between an engine with a high ratio of *cruise* thrust to weight, and one designed principally for a low fuel consumption, like the J-57.

For it is clear that, for some time to come, the J-57 is going to be the standard, efficient, all-purpose jet engine, for fighters, bombers—and transports.

END

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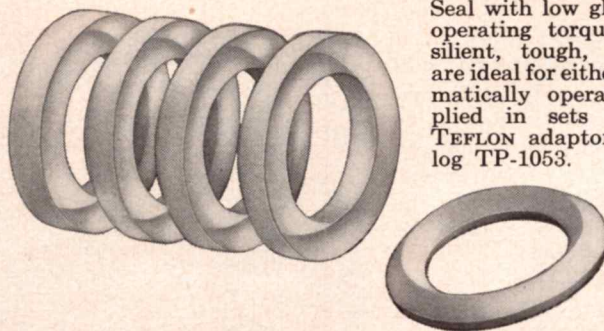
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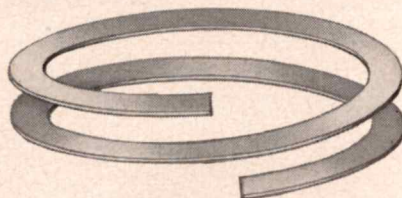
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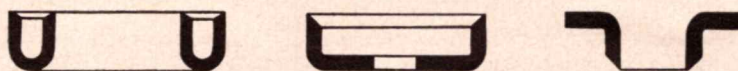
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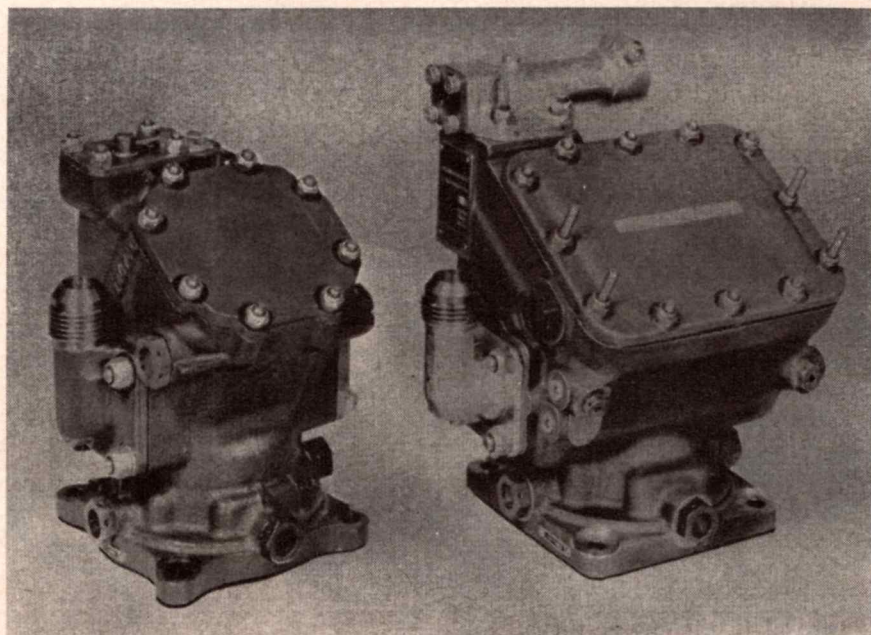
New Vickers design achieves 37 percent weight savings
and 33 percent size reduction over previous models

A NEW line of variable displacement hydraulic pumps for aircraft applications that achieve up to 37 percent savings in weight and as much as 33 percent reduction in size is now in production at Vickers Incorporated. The improved pumps feature a redesigned yoke and a housing made of magnesium-zirconium alloy.

In tests recently completed by Vickers, the new pump has demonstrated its ability to retain the high volumetric efficiency (more than 96 percent) and high over-all efficiency (more than 92 percent) of predecessor designs. The pumps operate with substantially lower critical inlet pressures than former designs. The lightweight unit passed the rigid 560 hour test dictated by military requirements at speeds from 750 to 4500 rpm and 3000 psi load and finished substantially in "new unit" condition.

The new pump series is designed for 3000 psi operation and is available in sizes having nominal rated deliveries (at 1500 rpm) from 0.60 to 233 gpm. The smaller size pumps can operate at speeds as high as 9100 rpm. The basic operating temperature limits of minus 65 deg. F. to plus 160 deg. F. are easily met. The pumps are readily receptive to operation at higher or lower temperatures. Porting can be supplied at the purchaser's option and pump rotation can be either left-hand or right-hand.

The pumps can be of either unidirectional (capable of a single direction of oil flow) or over-center design (capable of reversing oil flow). Cylinder controls can be provided to automatically maintain a selected pressure while delivering a varying flow depending upon system requirements. An electric depressurizing control can be provided which will cause the pump to lock at minimum pressure and zero displacement while remaining prepared to



meet system requirements upon demand. Servo control arrangements are available which permit remote control of hydraulic power in response to an electronic signal of a few milliamperes. A simple control piston can be provided for the variable displacement pump which will respond to hydraulic control pressures originating in a device supplied by the customer apart from the Vickers hydraulic components.

The new pumps are designed to provide a continuous non-pulsating source of hydraulic power in varying volume to be used as required for the operation of aircraft hydraulic equipment. They are axial pumps having nine pistons. Stroke of the piston and, hence, displacement of the pump, is determined by the angular relationship of the cylinder block and the drive shaft axes. The angle is determined

by the position of the yoke which is established by the control element of the pump.

Axial arrangement of cylinders minimizes inertia forces of rotating parts, avoiding the need for the large bearings usually required in making high rotative speeds practical. The yoke pintles are not subject to unbalanced forces due to mechanical driving loads or hydraulic operating pressure. Forced feed lubrication to connecting rods, pistons, valve faces and pintles assures a positive oil film on all bearing surfaces under load. All working parts are continuously submerged in circulating oil.

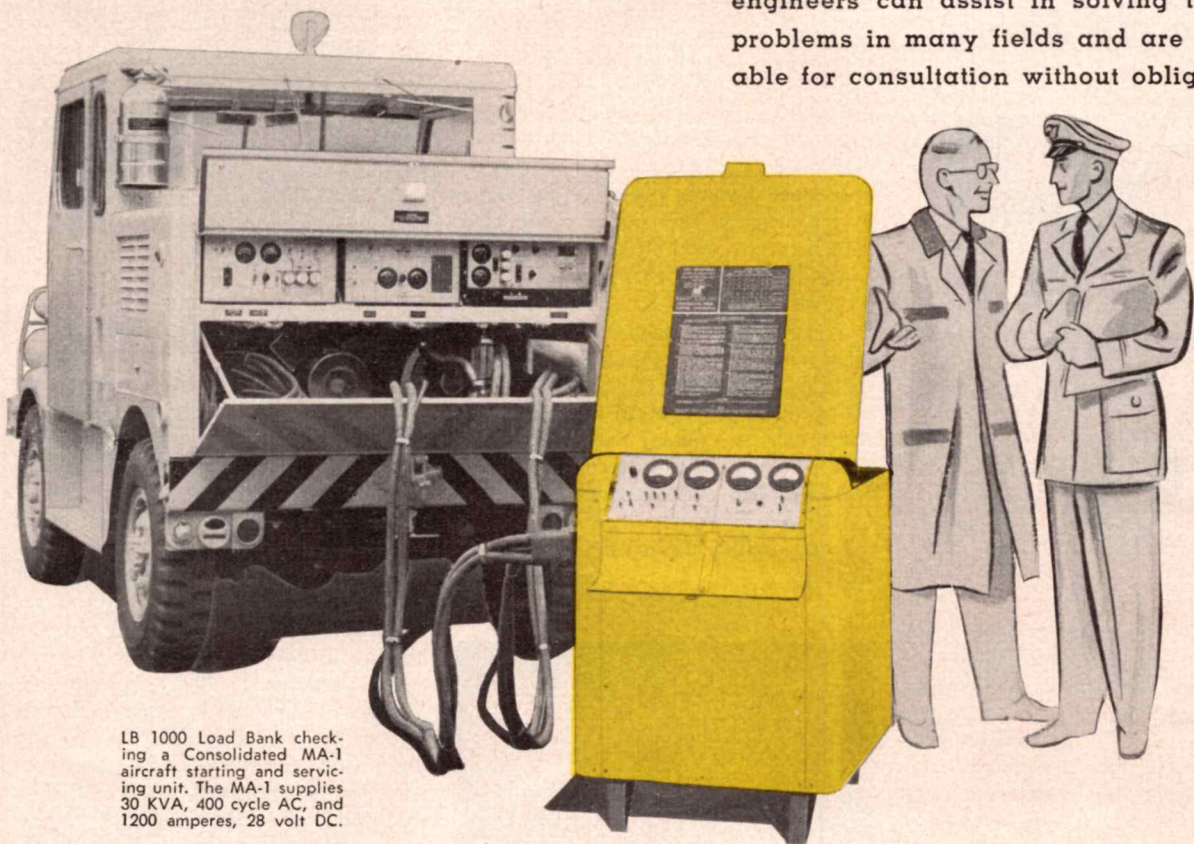
Hydraulic oil enters the variable displacement pump through a flange-mounted fitting at the yoke pintle. Passages in the yoke carry the oil to the valve plate which ports the oil into the cylinders where it is loaded to

±?

Plus or Minus errors are expensive when valuable aircraft equipment is being started, serviced, or tested. Consolidated load banks provide a wide range of protection for electrical systems and components.

Foolproof and portable, Consolidated load banks assure stable DC, and/or AC, testing for shop, field, and line. They are compact, self-contained, self-cooled, and available in many types and capacities.

Consolidated research and development engineers can assist in solving testing problems in many fields and are available for consultation without obligation.



LB 1000 Load Bank checking a Consolidated MA-1 aircraft starting and servicing unit. The MA-1 supplies 30 KVA, 400 cycle AC, and 1200 amperes, 28 volt DC.

CONSOLIDATED
diesel electric CORPORATION

AIRCRAFT EQUIPMENT DIVISION

STAMFORD CONNECTICUT

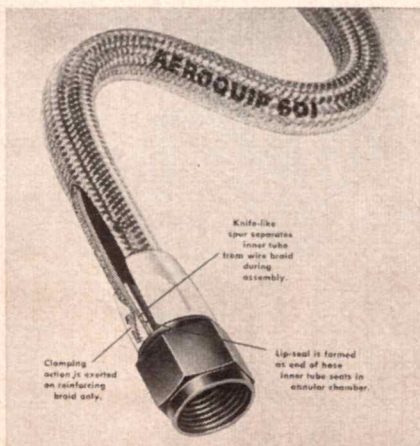
OFFICES IN • DAYTON, OHIO — B-4 TALBOTT BUILDING • SANTA ANA, CALIFORNIA — SPURGEON BUILDING • WASHINGTON, D. C. — CAFRITZ BUILDING

NOVEMBER 1954

rated pressure and passed back to the system. Inlet and outlet oil passages in the pump are identical.

Two pump housing configurations are available. One allows movement of the yoke up to 30 deg. maximum on one side of center (uniflow type) and the other allows movement of the yoke to both sides of center (over center type). In center position (zero displacement), the center line of the cylinder block is coincident with the drive shaft center line. Although the pump may be turning, no oil will be delivered because the pistons do not reciprocate in the cylinder block. As the yoke moves away from the center, oil is delivered in increasing quantity until full flow position is reached.

In those cases where the yoke may move to either side of center, movement from left to right of center will reverse the oil flow. The change in oil flow takes place without any special valving or complicated mechanical devices which would affect parts rotation. Flow reversals may be made at rated speed and pressure or delivery may be reduced to zero while rated pressure is maintained at either port. Vickers, Inc., 1400 Oakman Blvd., Detroit, Mich.



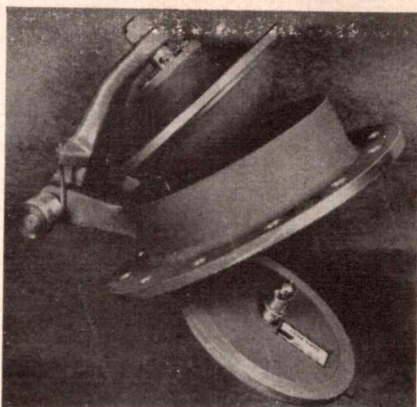
Fuel Hose

Aeroquip Corporation has announced its new 601 lightweight engine hose for medium high pressure aircraft fuel, oil and low pressure hydraulic systems. The assemblies simplify engine plumbing design by virtue of substantially increased flexibility and reduced weight. Weight savings are attained by reducing hose to the simplest construction required to meet maximum power plant operating pressures. Reinforcing wire diameters are varied according to hose size and the conventional cotton cover replaced by a stainless steel wire braid. Total cross-sectional area of the hose has been reduced by as much as 34 percent according to engineers.

The inner tube is a specially formu-

lated Buna-N compound compatible with both synthetic and petroleum based oils as well as new type aircraft fuels.

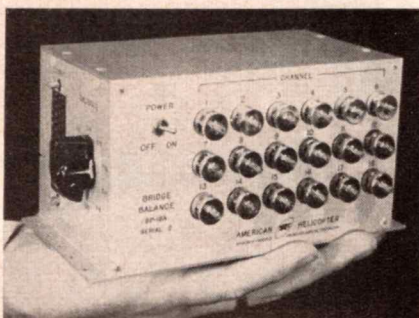
Aeroquip Corp., Jackson, Mich.



Unforgetting Gas Cap

The gas cap that never forgets, an accident-proof fuel filler cap, has been approved by the Air Force and is now in production by the Santa Anita Engineering Company. Even if the top dust cap is left completely unfastened, no gasoline can drain out or siphon out in flight. A perfect seal is provided by a patented self-aligning seat that will always seal. The semi-spherical internal trap door seal is spring-loaded to remain closed at all times except when a fuel nozzle is inserted into the tank, and the greater the internal pressure, the tighter the seal. The new filler cap has been tested to 250 psi without leakage or failure. The new cap fits standard 4 in. AN mountings and weighs 1 1/2 lb. No safety chain is required and the dust cover can be opened with a five-cent piece. Even if the dust cover is inadvertently left unlocked, no fuel can escape.

Santa Anita Engineering Co., 2451 E. Colorado St., Pasadena 8, Calif.



Channel Bridge Balance

New Model BP-18A Eighteen Channel Bridge Balance has been introduced by American Helicopter. This instrument has provisions for con-

trolling the electrical balance, sensitivity and calibration of resistance bridge sensing devices, such as strain gauges, accelerometers and pressure pickups. It is the smallest and lightest unit of its kind known. It weighs 2.4 lb. and its overall dimensions are 7 1/8 in. x 3 1/2 in. x 3 1/2 in. Ten-turn potentiometers with shaft locks are used for circuit balancing. Calibration resistors are accurate to within ± 0.1 percent, operating over a -40 deg. to 200 deg F. temperature range with a temperature coefficient of 0.00002 per deg. The model is ideally suited for use in aircraft and guided missiles flight instrumentation as well as a laboratory instrument.

American Helicopter, Division of Fairchild Engine and Airplane Corp., 1800 Rosecrans Ave., Manhattan Beach, Calif.



Siesta Seat

Introduction of a new model siesta-type seat line is being made on the Boeing 377 Stratocruiser of the Pacific-Alaska division of Pan American World Airways, it was announced by Hardman Tool and Engineering Company. The new model has folding legs and backs for minimum stowage space requirements. A convenient lift-type recline control lever is located on the front section of the armrest. The seat can either be mounted on tracks affording easy adjustment and position locking in one-inch increments or any type permanent floor installation. Weight of the double chair is slightly under 68 lb., although the rugged aluminum tubular basic frame construction is approved for 9 G's. The seat and back cushion are of 100 percent airfoam construction, scientifically contoured to reduce flight fatigue in exclusive Hardman-designed molds. Ashtrays are of well-type with a roll top and an easy-to-empty receiver. A complete line of seat accessories is available for the new model.

Hardman Tool and Engineering Co., 1845 S. Bundy Dr., Los Angeles 25, Calif.

Where's "Charlie"?

The "bird" will find him!

As it rockets along at supersonic speeds—high above the earth—its guidance system directs it unerringly to target "Charlie."

Electronics makes today's accurate missile guidance a reality—and *electronics* is the past, present and future of RCA.

For years, RCA has been working with the Armed Forces on design and

engineering of more accurate, more effective missile-guidance systems. The same RCA engineering facilities—from original planning to final production stages—are available for development of complete electronic systems of all kinds. For additional information, write to Government Department, Engineering Products Division, Radio Corporation of America, Camden, N. J.



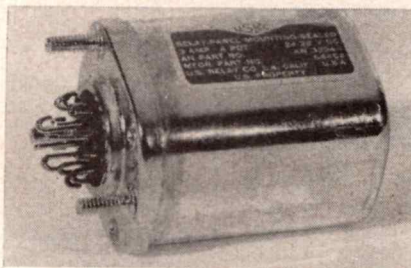
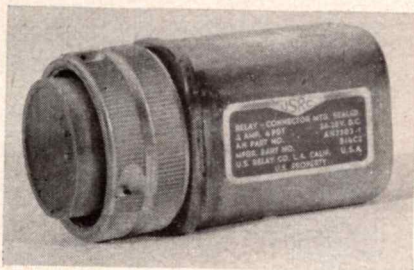
GOVERNMENT DEPARTMENT

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DIVISION

CAMDEN, N. J.





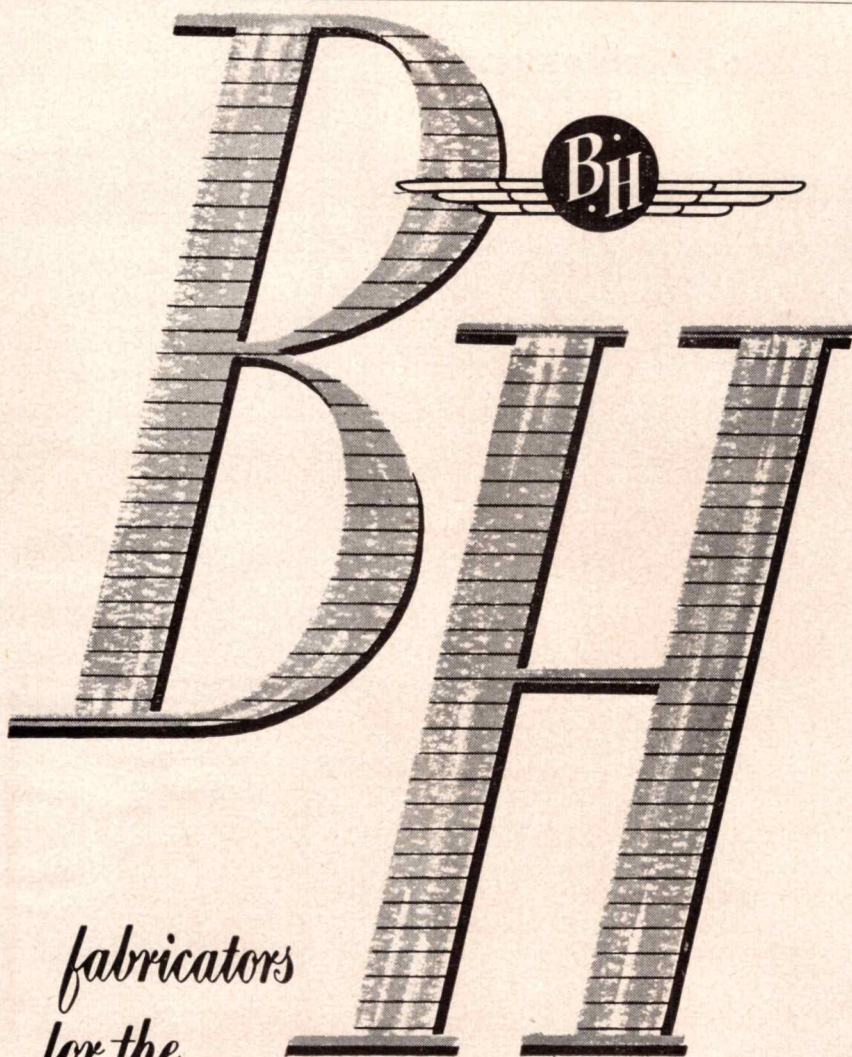
Electronic Relays

Two electronic relays which surpass all military requirements have been developed by U. S. Relay Company. The new units, both four PDT, continuous duty relays specifically de-

signed to meet guided missile requirements, can withstand 10-G high frequency vibration at 500 CPS; operational shock of 50-G, and will handle a 5 amp. resistive contact load, company officials claim. MIL specifications

for both AN 3303 and AN 3304, U. S. Relay Nos. 814C2 and 644C2, call for vibration of only 10-G up to 55 CPS; operational shock of 25-G, and a 3 amp. resistive load. High operational and vibration characteristics of the units, both operable in any position, are attributed to a well-balanced and compact design; four-point suspension permitting high tension spring values on the blade. AN 3303 is AN connector-mounted and weighs less than .500 lb. AN 3304 is stud-mounted; solder terminals. Weight: .225 lb. Both are hermetically sealed. Ambient temperature range: -55 deg. C. to 71 deg. C.

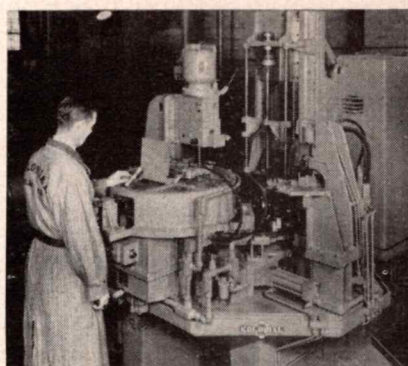
U. S. Relay Company, 1744 Albion St., Los Angeles 31, Calif.



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aircraft industry*

B.H. AIRCRAFT CO. INC.

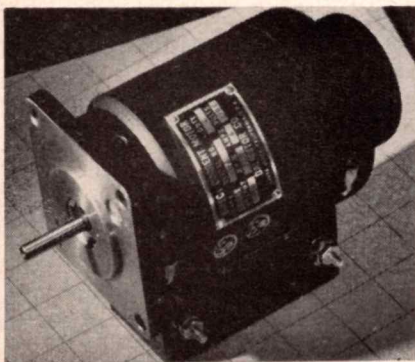
FARMINGDALE, NEW YORK



Triple-Duty Automated Unit

Following the trend towards automation in all metalworking fields, the Colonial Broach Company has developed an automated 3-station machine to include a drill unit, a broaching machine, and a stamping unit. All individual operations are performed on a single common base in one continuous cycle. All three individual machining operations are grouped around the heart of the automated machine—the loading and indexing mechanisms. Key to this particular unit is the table loading and indexing mechanism. The indexing table is located off-center and below the loading table. Parts are loaded—sprockets in this case—six at a time into circular holders on the ends of oscillating loading arm. Each holder contains an escape mechanism allowing the sprockets to drop, one at a time onto the indexing table. When the sixth sprocket drops, it triggers a switch that swings the arm around to a position where the empty holder is reloaded and the holder on the opposite end begins discharging parts into the chucks on the index table. The rotating index table is hydraulically actuated.

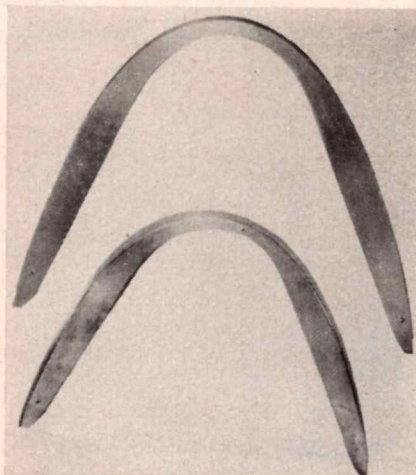
Denham and Co., 926 Book Bldg., Detroit, Mich.



Constant-Speed Motor

Capable of maintaining a constant governed speed of 7100 rpm from 24 to 30 v. d-c, the new Type SC-23 motor simultaneously meets all military specifications for temperature, pressure, and humidity requirements in airborne equipment. It is produced by the Dalmotor Company. Engineered to meet special requirements of a speed-regulated, radar-antenna spin motor, the unit offers application advantages in this and similar services. Radio-interference specifications are met by the design of a radio-noise filter mounted directly on the motor frame, and carrying power terminals for input voltage. Operating on 27-v. d-c, the unit is rated at $\frac{1}{8}$ -hp, and draws 6 amp. d-c. It is rated for continuous duty and provides a locked-rotor torque of $9\frac{5}{8}$ lb in. Total weight is 5.5 lb.

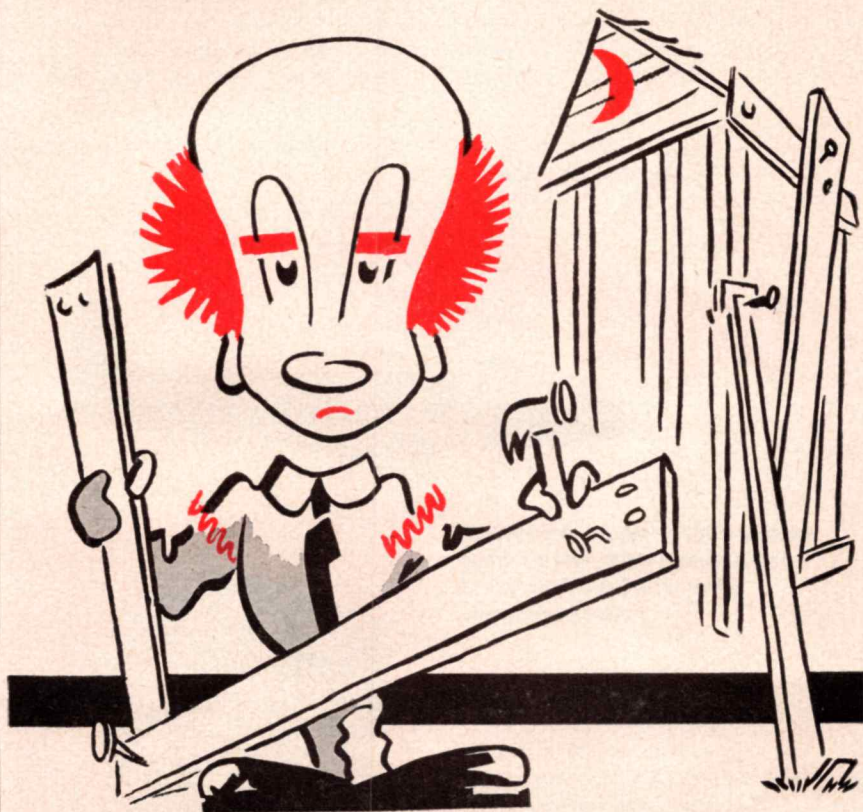
Dalmotor Co., 1302 Clay St., Santa Clara, Calif.



New Aluminum Plate

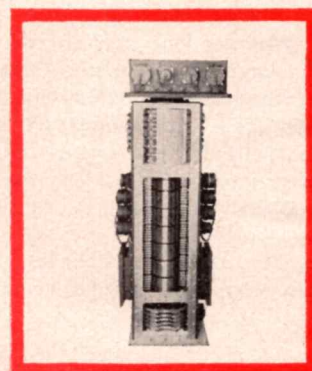
A new type of aluminum tool and jig plate—rolled and stretched 61S-T66 plate (6061-T66 under new alloy designations effective October 1, 1954)—is introduced by Kaiser Aluminum & Chemical Corp. Because it is a wrought alloy product that is stretched and stress-relieved, this new tooling plate provides the advantages of high density

Where there's a need



IF YOUR NEED IS TO GET ELECTRIC CURRENT FROM A STATIONARY WIRE TO A ROTATING OBJECT, THERE'S NO ONE WHO CAN DO IT BETTER THAN PMI

From miniature one circuit slip ring assemblies to giant 8-foot complete installations, PMI can produce electro-mechanical devices to meet your most exact requirements.



PROJECT 13E270

S.R.A. for ground-to-air radar. Customer: Goodyear Aircraft Corp. Rings carry 208 volts RMS 60 cycle. Circuits withstand 2,500 volts RMS 60 cycle. Adjacent ring cross talk at 30 mc is 60 DB. 80 Circuits.



P M INDUSTRIES, INC.
276 FAIRFIELD AVENUE
STAMFORD, CONNECTICUT

and improved yield, tensile and compressive strengths as compared with cast plate, as well as economy. Tests by Kaiser Aluminum and commercial users have already shown that the stretched tooling plate is well adapted for hydropress and stretcher form blocks, jig assemblies, templates and other tooling uses. Prominent among its properties are high dimensional stability, provided by the special fabricating practices and thermal treatments used in obtaining the T66 tem-

per, and internal stress relief resulting from stretching. The plate carries a flatness specification of $\frac{1}{8}$ in. in 6 ft. or any lesser dimension. A series of rigorous tests given by the Fort Worth, Tex., plant of Convair, to a form block made from $1\frac{1}{4}$ in. thick 61S-T66 plate indicates its adaptability to this type of use. The block shape, an open horseshoe, was chosen because of the exacting demands as regards serviceability and dimensional stability.

After being used to form several

parts from 24S aluminum, the block was bumped into the hydropress rubber many times. Then, a part was placed over the block and the outer flange hand-straightened by hammering. Subsequent measurements revealed no warpage of the 61S-T66 block in any direction and the template fitted perfectly. The same block was later heated for forming a magnesium part and further bumping several times. On heating, the width across the open end of the horseshoe increased by $\frac{3}{32}$ in. but there was no perceptible warpage. On cooling to room temperature, the block returned to its exact original dimensions. For many applications the smoothness of the rolled 61S-T66 tooling plate will make it unnecessary to machine the surface. However, if machining is required, the stress-relief resulting from stretching effectually prevents the possibility of distortion. The machined surface ordinarily is smoother and brighter than that obtained from cast tooling plate, although the machining process may require slightly longer time. Typical mechanical properties of the 61S-T66 plate include: tensile strength, 42,000 psi; yield strength, 37,000 psi; elongation, 10 percent.

The rolled and stretched plate is available up to a maximum size of 100 in. wide, 396 in. long and $2\frac{1}{4}$ in. thick. Introduction of the new tooling plate in this extended size range is made possible by the 5,000,000 lb. plate stretcher, the world's largest, at Kaiser Aluminum's Trentwood rolling mill.

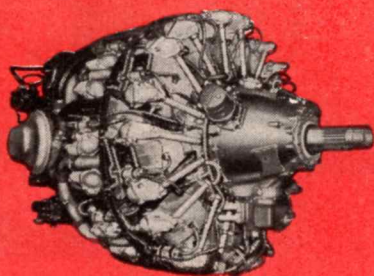
Kaiser Aluminum & Chemical Corp., 1924 Broadway, Oakland 12, Calif.

Congratulations!



to Curtiss-Wright Corporation on the powerful Turbo Compound engines used in American Airlines' DC-7 Flagships for non-stop transcontinental service.

We are proud to be a supplier of precision components used in this 3250 horsepower engine—parts which require a high order not only of dimensional accuracy and superfine workmanship, but also of metallurgical technique.



We have long specialized in the production of precision components for the aeronautical and automotive industries. Into these components go the same exacting care and specialized skill that have made A·B·C Drill Jig Bushings and A·B·C Piercing Punches the quality standard.

Our facilities include automatic blanking, heat treating, centerless and

cylindrical internal and external grinding, a wide variety of honing and lapping machinery—and the most modern types of precision inspection equipment.

Our engineers are well versed in the processing of correct steels for specific applications, making due allowance for shock resistance and wear and abrasion, as well as for cost.

Write us about your requirements.

ACCURATE BUSHING COMPANY

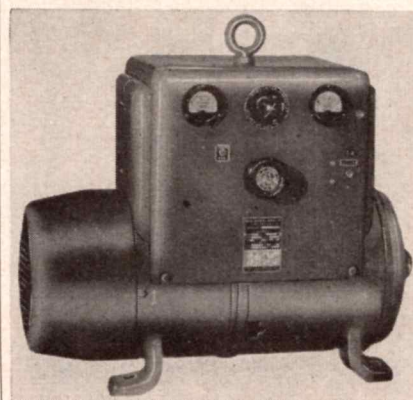


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Representatives in major industrial centers

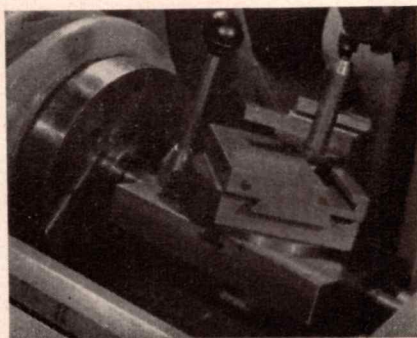


Power for High Cycle Tools

A new line of motor generator frequency changers, designed to convert 60 cycle current into a 180 or 360 cycle power source for operating high cycle tools is now available from Motor Generator Corporation. The sets, in 5, 7.5, 10, and 15 kw capacities, are compactly designed, of two-bearing

construction with the motor rotor, exciter armature, and revolving field mounted on a solid steel shaft—dynamically balanced for quiet operation. The monitor top houses all motor and generator controls and instruments. Output voltage of the equipment is little affected by voltage fluctuations in the incoming power supply. Regulation of output voltage is 3 percent, while frequency regulation is within 3 percent. The unit-type design is especially suitable for a departmentalized high cycle power source.

Motor Generator Corp., Hobart Sq., Troy, O.



Adjustable Wheel Dresser

Grinding wheels are dressed to any angle desired with accuracy and considerable speed at TEMCO Aircraft Corp., Dallas, Tex., where a Hardinge lathe compound (or head) do the dressing. The compound can be mounted between the centers on cylindrical and thread-grinders, or it can be used on surface grinders.

TEMCO's thread-grinders have automatic provisions for dressing their grinding wheels to angles of 15 or 30 deg. But any other degree of angle formerly had to be dressed by hand. This was time-consuming and sometimes inaccurate. TEMCO grinder operator Harold E. Hall devised the adjustable wheel dresser. He mounted the Hardinge compound—with attached degree marker—on a $4\frac{1}{2}$ x $6\frac{1}{2}$ -in. block of $\frac{1}{2}$ -in. steel with a T-bolt slot. Then he drilled a center hole at each end of the block, 90 deg. to the slot. Thus, when the Hardinge compound is mounted between the centers in a grinder, the zero point on the degree marker is opposite the edge of the grinding wheel and perpendicular to its axis. The diamond-holder on the Hardinge compound can be swiveled, lined up and locked at any one of the 360 deg. marks on the degree-marker. Thus, if the compound is set 14 deg. to the right of zero on the marker, for example, it will cut a precise 14-degree angle on the left side of the grinding wheel.

highest

and fastest

Bell Aircraft's X-1A rocket-powered research plane has flown higher and faster than any other piloted aircraft in the world.

While these two world records are outstanding achievements in aviation history, their importance as altitude and speed marks is overshadowed by their more significant contribution to aeronautical research. Both these records were attained as a normal part of the continuing research program so necessary to the continued growth of the U. S. Air Force.

From these flights, data pertinent to human as well as aerodynamic reactions at high speeds and high altitudes are constantly being accumulated. Much of these data are already at work in the nation's supersonic aircraft, guided missile and rocket propulsion efforts.

The creative thinking, sound engineering and advanced developmental and production planning that are an inherent part of all Bell productions, made the performance of the X-1—the world's first supersonic aircraft—and its successor, the X-1A, more than record-shattering flights. They are milestones of research... the kind of research that Bell Aircraft Corporation is contributing to the needs of national defense and this country's military and economic future.

And there are excellent opportunities for qualified engineers and scientists to help carry on the programs which are making Bell famous for aviation firsts. Resumes are invited.

BELL

Aircraft CORP.

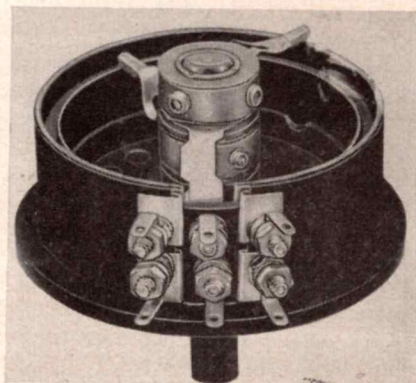
BUFFALO, N. Y. • FORT WORTH, TEXAS

The U. S. Air Force offers careers to AIRMEN. Enlist today!

The diamond-holder has a lateral travel of $\frac{3}{4}$ -in. in a dovetail slide. This travel governs the width of the cut made on a grinding wheel. Wheels dressed with a Hardinge compound are accurate to 30 minutes. This precision, and the ability of the Hardinge compound to dress wheels to any angle, permits operators to do a variety of grinding jobs on their conventional machines. Thread-grinder centers, and other types of live centers, can be re-ground with absolutely

no run-out. Draw broaches with 7-deg. primary lands and 45-deg. secondary lands, which TEMCO fashions from scrapped reamers, are ground on the company's thread-grinders. In addition to the new grinder applications it has developed, the Hardinge compound adaptation is saving time at TEMCO. Wheel-dressing time has been reduced at least two hours a week.

TEMCO Aircraft Corp., P.O. Box 6191, Dallas, Tex.



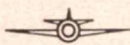
Virtually all wing tanks now in use embody the original Fletcher Aerodynamic design.

Fletcher has the most experienced group of engineers in America concerned with wing tank production exclusively.

Fletcher Engineering's Original
design and development revolutionized the external component industry



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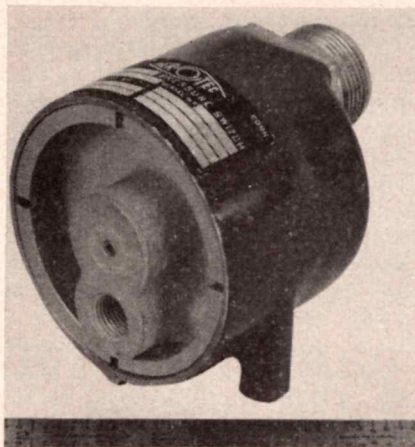
*World's largest designers and manufacturers
of external wing tanks*

Fletcher Airport • Rosemead, California
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Offshore Affiliates: Oslo, Norway • Tokyo, Japan

New Potentiometers Series

DeJur-Amsco Corporation standard and power potentiometers are available in six basic models with a wide range of functional and mechanical variations in each series, including linear and non-linear functions. A feature of certain types in this series include indicated angles of rotation of 360 deg. mechanical and 356 deg. electrical, to provide maximum resolution. Some models are available in multiple ganged arrangements, shafts extended through either or both ends, self-aligning multiple finger brush contacts, and locking type shafts. Potentiometers are engineered for sustained accuracy. Housings are reinforced Bakelite or aluminum and are available in fungus-resistant Melamine materials.

DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

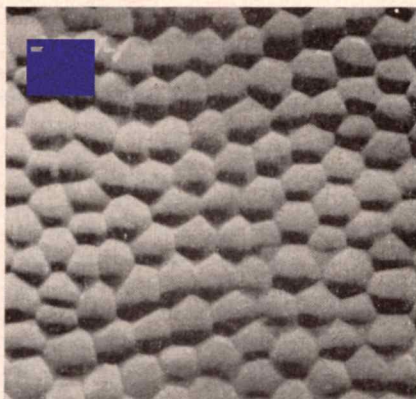


Adaptable Pressure Switch

The new Aerotec Universal Pressure Switch announced by the Thermix Corporation, project engineers for Aerotec features design simplicity and construction, compactness and lightweight—as well as its universal application. The Aerotec Switch has approximately 25 parts. Used either as a differential, gauge or absolute pressure switch, this instrument withstands

the vibration, extreme temperatures and high altitudes of today's most advanced military aircraft and commercial planes. Its pressure-tight switch housing of Monobloc construction is impervious to the deteriorating effects of sand and dust, salt spray, humidity, and fungus. And its explosion-proof, double metal wall separates fuel and electrical components for absolute safety and highly efficient, dependable performance. As a gauge pressure switch, this unit can accommodate actuation pressures of 1 to 3500 psi, the higher pressure ranges naturally requiring modified internal parts. For differential pressure applications the range is 1 to 500 psi. The U switch can also be supplied as an absolute type, accommodating pressures of 15 psia to 60 psia. The usual mediums encountered in aircraft applications, such as aviation fuel, hydraulic fluid, engine oil, air, and nitrogen, are suitable for the U switch. The weight of this Aerotec pressure switch series varies from .7 to .8 lb., with the gauge units being the lightest.

Thermix Corp., project engineers for The Aerotec Corp., both of Greenwich, Conn.



New Rigid-Tex Metal Pattern

Expensive hand-hammered metal effects are available in any metal, strip or sheet, up to 38 in. wide, at a fraction of their former hand-finished costs. The new three-dimensional pattern is produced by the Rigidized Metals Corporation. With a maximum depth of .025 in. on metals up to .0312 in. thick, the pattern provides beauty with increased strength, lower weight and mar resistance. Particularly attractive effects have been achieved with stainless steel, copper, brass and aluminum. Finishes available: mill finish as rolled, mill finish with highlights, colored and highlighted, painted or porcelain enameled without highlights. Reverse side of sheet gives added effects.

Rigidized Metals Corp., 675 Ohio St., Buffalo, N. Y. END

ERCO

saves the military both lives and dollars

For years the military was plagued with this very serious problem: flight training was costing lives, costing airplanes, costing money. How could the problem be licked?

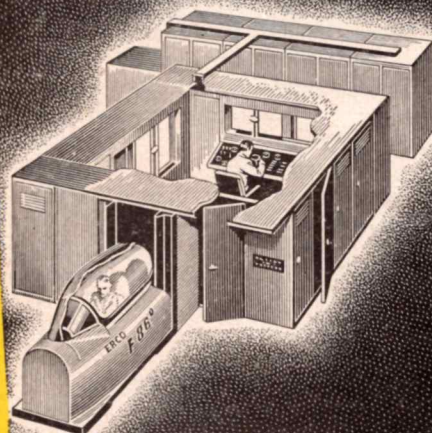
ERCO came up with the answer — designed and built the first combination flight and tactics trainer . . . designed and built the first flight simulator for the F 86D . . . designed and built the first trailerized operational flight trainer . . . helped reduce flight accidents to a remarkable low!

ERCO builds simulators for more different airplanes than any other manufacturer

Make ERCO your scientific research department — your engineering staff — your extra plant when the job calls for:

ELECTRONICS • ANALOG COMPUTERS
AIRBORNE ARMAMENT
MACHINERY • COUNTERMEASURES
AIRCRAFT EQUIPMENT
GUIDED MISSILE COMPONENTS
SHEET METAL FABRICATION

ERCO produces what ERCO designs



ENGINEERING and RESEARCH CORPORATION
RIVERDALE, MARYLAND

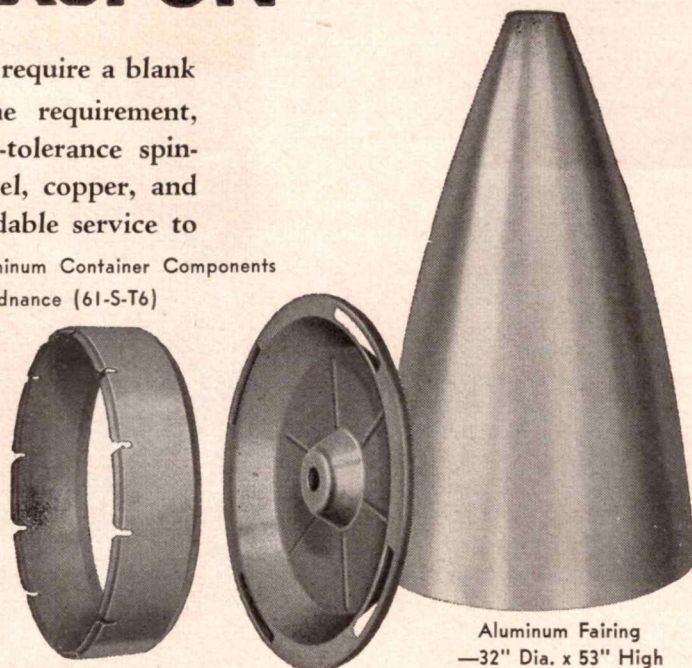
For Metal Spinning At Its Best

The Word Is "PHOENIXSPUN"

YOUR part may be as small as a thimble—or require a blank up to 180 inches in diameter. Whatever the requirement, PHOENIXSPUN craftsmen can produce close-tolerance spinings from steel, stainless steel, aluminum, monel, copper, and other metals. More than twelve years of dependable service to leading industries in widely diversified fields.

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Aluminum Fairing
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Milwaukee 16, Wis.

TRADE LITERATURE AND PAMPHLETS

CAA Statistical Handbook

The enlarged 1954 edition of the CAA Statistical Handbook of Civil Aviation, containing a quantity of new material on general aviation, is now available through the U. S. Government Printing Office.

This seventh annual issue of the Handbook, which is the standard statistical report on the status of civil aviation in the United States, includes all available statistics on major aviation activities to January 1, 1954. It shows increased activity in almost every segment of the industry.

The Handbook is available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for 50 cents.

Small Diameter Ducting

A four-page folder gives essential information on "Flexflyte" small diameter flexible tubing engineered for air handling, fume removal, exhaust and other industrial uses. This lightweight reinforced fabric duct withstands wide temperature ranges and

high pressures. It is especially suited to installations where space is limited or where intermittent or continuous flexing is required. Depending on the type, the tubing is composed of an inner core of either sheet rubber, coated Fiberglas or cotton over which a helix of steel wire is bound by a treated Fiberglas cord to provide a strong unitized tubing. Tables, charts, cutaway diagrams and other illustrations show the materials and construction features of the ducting. Diameters range from 1/2 in. to 10 in.; available in standard 12-ft. lengths or longer.

Flexible Tubing Corp., Guilford, Conn.

Instrument Gears

A colorful catalog illustrates the kind of work performed by Micon in the field of precision instrument gears. The company specializes in hobbing, cutting, shaving, cylindrical grinding, internal grinding, and thread grinding of gears. Included are spurs and helical gears, pinions and sectors, internal gears, worms and worm gears, armature and splined shafts, cluster gears, ratchets, shaved tooth gears, fine pitch gears from 16 to 200 dia-

metrical pitch up to 4 in. in diameter. Made to exacting specifications and close tolerances, quality is in conformance to AGMA standards. These gears are used in instruments, actuators, autopilots, automatic flight controls, calculators, computing machines, control systems, servo-mechanisms, synchro generators and many other devices.

Micron Gear Mfg. Co., Dept. P, 102-38 Corona Ave., Corona 68, N. Y.

Copper Today and Tomorrow

A booklet by CABRA, trade association of copper and brass fabricators, presents a comprehensive analysis of the productive capacity of the copper industry. This productive capacity is projected into the future and balanced against estimated requirements. Figures used were drawn from the U. S. Bureau of Mines and other authoritative sources. Subjects discussed are: How much copper will we need; Where will the copper come from; U. S. mine production; Scrap is a vital factor; Imports maintain the balance; Copper reserves; and The outlook for copper. Two-color graphs and many diagrams supplement the text and give an interesting explana-

tion of the factors involved and which affect the aviation and electronics industries.

Copper & Brass Research Assn., 420 Lexington Ave., New York 17, N. Y.

Aluminum Extrusions

A comprehensive study of aluminum extrusions by G. Roger Smith, head of the Technical and Development department of Harvey Aluminum, has just been published. The study points out the many uses to which the aluminum extrusion can be applied in new design, and is an aid to those who are now using the aluminum extrusion in improving existing designs. Technical material covered include current applications, design advantages, fabricating finishes and general characteristics.

Harvey Aluminum, 19200 S. Western Ave., Torrance, Calif.

Hardness Tester

Brochure F 1689-2 presents technical data on the Barcol impressor, a portable hardness tester for aluminum, aluminum alloys, copper, brass, and other metals and materials, including plastics. Hardness reading is instantly indicated on a dial as the instrument is lightly pressed against the material. It is useful for testing fabricated parts and assemblies, as well as raw stock. The impressor comes in three models, one having a range of 25 to 15 Brinell, one for 25 to 110 Rockwell, and one for extremely soft materials and metals such as lead.

Barber-Colman, 1200 Rock St., Rockford, Ill.

Silver-Zinc Batteries

A technical brochure describing the advantages and features of AMF silver-zinc primary and secondary batteries is available from the manufacturer. These batteries, in both single and multiple cell construction, are available in sizes ranging from one smaller than a pack of cigarettes to one for starting jet engines. The smaller units are used in advanced electronic weapons of a classified nature. Features are uniform discharge of voltage, high drain rates and high power output per unit volume. The brochure includes graphs, charts and specifications.

AMF Contract Div., American Machine & Foundry Co., 261 Madison Ave., N. Y. 16, N. Y.

Chromium Cylinders—By adopting a process of chromium plating for the walls of engine cylinders, the U. S. Navy reports savings of more than \$15-million in extended service life of the equipment. Life has been increased from 1200 to 3000 hours of operation. Elimination of cylinder bore corrosion cut piston and ring wear 50 percent.

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Firebee gets dunking as part of extensive water testing program

Sea-Going Firebee

Ryan Aeronautical jet target plane under-
 goes strenuous water recovery tests

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THE near-sonic, ground-con-
 trolled Ryan *Firebee* pilotless
 jet target plane has now taken to
 a new element—water—at the U. S.
 Naval Station, San Diego, Calif.

While it compares somewhat
 more favorably with a bird than
 with a fish, the *Firebee* has proved
 that, not unlike the much-publi-
 cized product of a well-known soap
 company, it, too, can float.

The buoyancy characteristics of
 the "bird" are of more than pass-
 ing interest to the U. S. Navy. With
 an undisclosed quantity of the
 high-speed aerial targets on order,
 the Navy is evaluating the *Firebee*
 for specific Navy use in an exten-
 sive flight-test program.

Assisting the Naval Missile Test
 Center (NAMTC) in this evalua-
 tion is a group of 12 Ryan engi-
 neers and technicians headed by
 Ronald A. Reasoner, Assistant
 Project Engineer. The Ryan group
 conducted the detailed preliminary
 work preparatory to actual flight
 tests.

The Navy version of the *Firebee*,

designated the KDA-1, is now in
 production at Ryan. Special flota-
 tion features insure recovery of the
 targets after they have parachuted
 into the sea. Ryan engineers estab-
 lished a design goal of one hour of
 flotation at the 50 percent fuel
 condition, although Navy specifi-
 cations call for only 25 percent fuel
 condition.

Foamed-in-place plastic flotation
 material was put in the wings, hori-
 zontal stabilizer and nacelle. Be-
 cause of the quantity of unsealed
 electronic equipment in the instru-
 ment equipment compartment, it
 was decided to seal this compart-
 ment to prevent water entry.

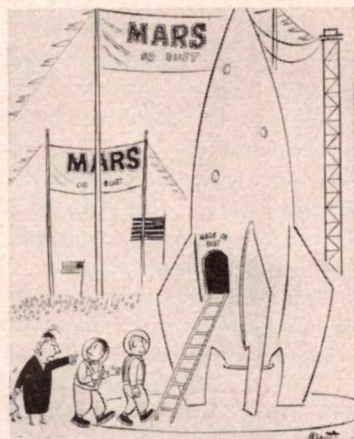
In the first of a series of three
 tests, the target plane—complete
 with J-44 turbojet engine—was bal-
 lasted at the 50 percent fuel load
 condition. A sling was attached to
 the plane so that it hung in the
 usual 10-degree tail down attitude
 assumed during normal parachute
 recovery; then it was unceremoni-
 ously dropped into the sea at a 20-
 fps impact—the same that occurs

in a normal parachute landing.

The target assumed a stable floating position almost immediately. In the 60 minutes it was in the water, it settled slightly by the nose from a two-degree to a five-degree nose-down attitude.

Subsequent tests were conducted with ballast at the 25 percent, and then the 90 percent fuel-load condition. Following completion of the latter test, the target was returned to the Ryan plant where it was allowed to stand 24 hours before being rinsed thoroughly with fresh water. For the next 30 days the target was inspected daily to determine what parts were affected by the salt water baptism.

Test results indicated that the flotation provisions were more than adequate to meet the required one



"And where do you think you're going?"

hour's flotation for half fuel load conditions. A study of the corrosive effect of the salt water revealed which areas of the target were most susceptible, and what should be done to eliminate corrosion in those areas.

Armed with this information, Ryan modified and delivered five Air Force Q-2's with flotation provisions to the NAMTC for use in the flight test program at Pt. Mugu. These provisions will, of course, be standard in the KDA-1's now under production and scheduled for delivery to the Navy in the summer.

Responsibility for the flight test evaluation of the sea-going *Firebee* rests with NAMTC's Missile Division III, commanded by Cdr. R. M. Hayler. The *Firebee* project officer is Lt. George Miller. **END**

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Lavelle believes in versatility—trains technicians, develops engineers, invests in only the very finest equipment—all aimed at developing an ever greater productive versatility.

This growing versatility, built up during years of experience in fabricating stainless steel, aluminum alloys and other allied materials has earned Lavelle a reputation as a truly unique and reliable subcontractor.

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Wanted: Better 'Copter Landing Gear

By LAWRENCE A. FINN, Chief Aviation Mechanic, U. S. N.

THE greatest shortcoming of today's helicopter under tough landing conditions is not its payload or balance limitations, but its

unadaptable fixed-wing landing gear.

Consider the operation of the helicopter in Korea. There, it per-

formed beautifully—until it was called upon to land or otherwise operate from the rugged and irregular terrain over which it so adeptly flew. It flunked miserably.

The built-in rigidity and inflexibility of the fixed-wing-type landing gear automatically restricted copters to the regularities of fixed-wing landing terrain. As a result, many man hours were needed and considerable delay in operations were experienced while some remote forward bit of area was leveled to permit the otherwise agile helicopter to safely sit down.

Again, at sea helicopter performance is chopped considerably by its comparatively rigid and unsuitable fixed-wing landing gear, which automatically transmits the rock and roll of the ship to the helicopter proper, continuously threatening to topple it over.

It is therefore suggested that those concerned with the overall design and operational adaptability of the aircraft consider the practicality of a helicopter landing gear combining more flexible characteristics. This could be accomplished with but a few component changes to the standard fixed-wing landing gear now in use.

A suggested design would include a hydraulic displacement well incorporated in, but independent of, each of the regular oleos. The well could be filled half full of fluid, with lines inter-connecting each to the other. The fluid flow would be controlled by the pilot through a solenoid-operated valve.

Using this configuration, the pilot, prior to landing on irregular terrain, would depress a button at the end of the collective pitch stick opening the displacement valve. The weight of the helicopter would then compress the displacement oleo of the wheel first contacting the terrain, forcing the fluid from it to the oleo of the wheel still airborne, extending that oleo in pro-



feet to safety

With pressure from the pilot's feet, tons of metal are brought to a fully controlled safe stop. Planes are landing faster and hotter, but with continually improved mechanisms such as Gladden's brake control units, greater power to control and stop is now possible. Gladden's ability to anticipate the requirements of the aircraft industry has made them a leader in the manufacture of brake control units. Today Gladden is in quantity production on the three major types of brake control units...

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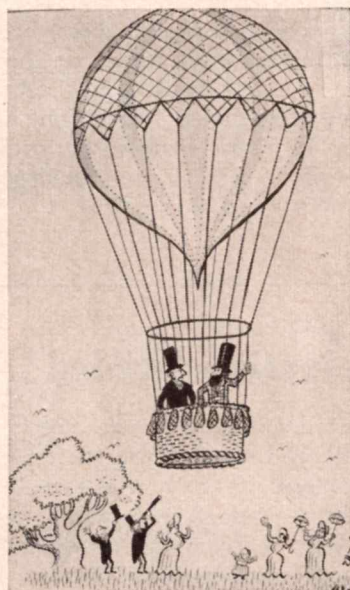
GLADDEN PRODUCTS CORP., 635 WEST COLORADO BLVD., GLENDALE 4, CALIFORNIA



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portion to the contraction of the first. This displacement principle would automatically continue until all wheels adapt themselves to the irregularity of the terrain, after which the regular oleos would absorb the weight of the helicopter.

The pilot would then release the displacement button locking the oleos in the displaced position, permitting the helicopter to be shut down. (A pressure type diaphragm valve could be incorporated in the system to permit automatic locking of the displacement oleos when a pre-determined pressure builds up



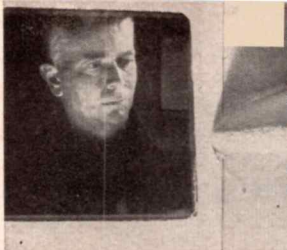
"Reckon we've got V. T. O. problems pretty well licked"

in the system by the weight of the fuselage.)

For shipboard operation, a pressure valve would not be as practical as manual control of the displacement fluid, since weight must be on the oleos, yet independent fuselage attitude permitted through cyclic control to counteract ship's roll.

It is estimated that by incorporating a one-foot displacement well in each of the standard oleos, the present operational helicopter could land on a twenty-three degree incline without toppling, as compared to eight degrees with the current fixed-wing gear. Also fuselage would remain level, independent of terrain inclination or ship's roll, up to 15 degrees.

During shipboard operations, the pilot, after gaining cyclic control of the fuselage, would depress



Carl Vrooman, icing tunnel group head, studies hot-air cyclic de-icing test on wing section of C-130 transport. The tunnel has a temperature range of -40° F. to $+150^{\circ}$ F. and maximum air speed of more than 270 mph.

New icing tunnel speeds thermodynamics research at Lockheed

Designed to meet a constantly increasing volume of thermodynamics work, Lockheed's new icing research tunnel now provides year 'round testing in meteorological environments normally found only in flight. It is the first icing research tunnel in private industry.

Lockheed thermodynamics scientists are now able to study in greater detail problems such as: thermal anti-icing; cyclic de-icing; various methods of ice removal; distribution of ice; rate of temperature changes in aircraft components; thermodynamic correlation between laboratory and flight testing; and development and calibration of special instrumentation.

C. H. Fish, design engineer assigned to the tunnel, measures impingement limits of ice on C-130 wing section. The tunnel has refrigeration capacity of 100 tons, provides icing conditions of 0 to 4 grams per cubic meter, droplet sizes from 5 to 1000 microns.



Thermodynamics Career Opportunities

Increasing development work on nuclear energy, turbo-prop and jet transports, radar search planes and supersonic aircraft has created a number of positions for Thermodynamics Engineers and Thermodynamicists.

Lockheed offers you increased salary rates now in effect; generous travel and moving allowances; an opportunity to enjoy Southern California life; and an extremely wide range of employee benefits which add approximately 14% to each engineer's salary in the form of insurance, retirement pension, sick leave with pay, etc.

You are invited to write E. W. Des Lauriers, Dept. AD-T-11, for a brochure describing life and work at Lockheed and an application blank.

B. L. Messinger, department head, analyzes test results with Thermodynamics Engineer E. F. Versaw (right) and Thermodynamicist Tom Sedgwick (left).



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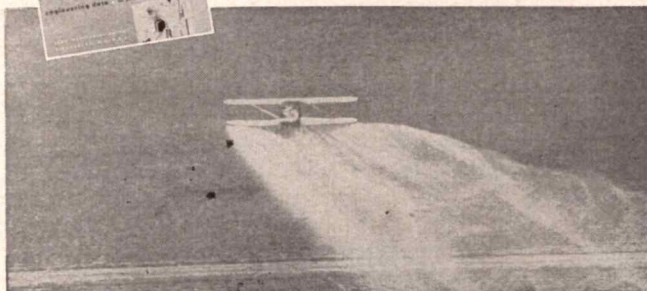
It's important in crop spraying to get thorough coverage of the crop. That calls for reliable equipment like the Aero Mist Master which depends on STOW flexible shafting to transmit power from the accessory gear box to the pump which delivers the insecticide to the spray nozzles beneath the wing.

According to Mabry I. Anderson, of Mississippi Valley Aircraft Service, manufacturers of the Aero Mist Spray System, "Your shafts have never failed—even though they've already given us thousands of hours of *trouble free* service".

Consider STOW flexible shafting for your next Power Drive or Remote Control application. Our engineering department will be happy to work with you. No obligation, of course.



Write today for your free copy of Bulletin 525 containing complete engineering data on STOW flexible shafting.
See us in SWEET'S CATALOG



STOW **MANUFACTURING CO.**
20 Shear St. Binghamton, N. Y.

the displacement button at the end of the collective stick, thus immediately gaining independent control of the fuselage over that of the ship's rock and roll—the displacement oleos automatically displacing themselves in compensation of the ship's attitude.

After take-off from a ship or irregular terrain the displacement button would be momentarily depressed, permitting light equalizer springs incorporated in the displacement wells to bring the gear to neutral, or nearly so.

Displacement oleos added to our present fixed-wing type landing gear would transform them to true helicopter landing gear. It should also sever the last link in the fixed-wing-to-helicopter transition, freeing the whirly birds to perform as intended—100 percent helicopter—on land as in the air. **END**

Scientists Needed

Unless drastic changes are made soon, the need for engineers and scientists in aviation as well as scores of other fields will become rapidly more acute, according to The Commission on Human Resources and Advanced Training. Harper & Brother have recently published a 332-page study by the Commission under the editorship of Dr. Dael Wolfe. Among the conclusions are:

The United States wastes the abilities of many of its most talented citizens.

Too many superior youngsters do not go to college. Failure to provide a college education for the most promising of the nation's youth "constitutes a gross neglect."

College educations in the sciences are too often impractical and not keyed to the work the student will do when he is graduated.

Too many older persons, talented and seasoned, are abandoned to retirement under rigid and unrealistic retirement rules.

The Human Resources study, which experts predict will become a standard reference, was completed after three years under a \$240 grant from the Rockefeller Foundation. **END**

Cessna Copter

Simplified rotor and transmission systems, making possible ruggedness and low-cost maintenance, are among the advantages claimed by Cessna Aircraft Company in its new CH-1 helicopter. The rotor-plane has been under development for more than two years and is now nearing completion of its Civil Aeronautics Administration certification tests.

With an airplane-type fuselage, a supercharged, fan-cooled 260 hp Continental 470 engine in its nose, a 35 ft. rotor and 300 lb. gross weight, the copter is expected to improve on standard speed in its field.

It was built under direction of Jack Leonard, Manager of the Cessna Helicopter Division, in which Charles Seibel is Chief Engineer. The Division was organized in 1952, when Cessna purchased the assets of a development company organized earlier by Siebel.

Fairchild Kinetics

A new Division for Kinetics, with offices at 1860 Broadway, New York, is announced by Richard S. Boutelle, President of the Fairchild Engine and Airplane Corporation. At the same time, Mr. Boutelle stated that the Corporation had absorbed Gassner Engineering, a specialized consulting group, with 11 years of successful operation in the aircraft, electronics, railroad, reinforced plastics, and special machinery fields.

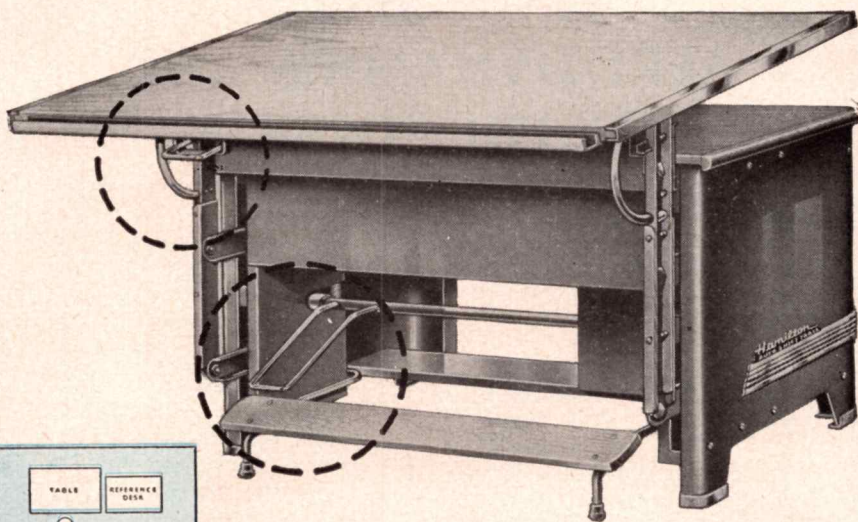
Alfred A. Gassner will be General Manager of the new Division. His group engineered the Talgo, a low-slung, experimental train first built in Spain, and "Train X," designed for the Chesapeake and Ohio, both of which attracted widespread interest.

The Gassner group, which has carried out extensive reinforced plastics research in association with Lunn Laminates, Inc., of Huntington Station, Long Island, will continue to carry out that work.

Mr. Gassner and his group have been associated with Fairchild on many projects, Mr. Boutelle said, and their present activities parallel many of those now under study by Fairchild, a consideration that led to the formation of the group as a new Division.

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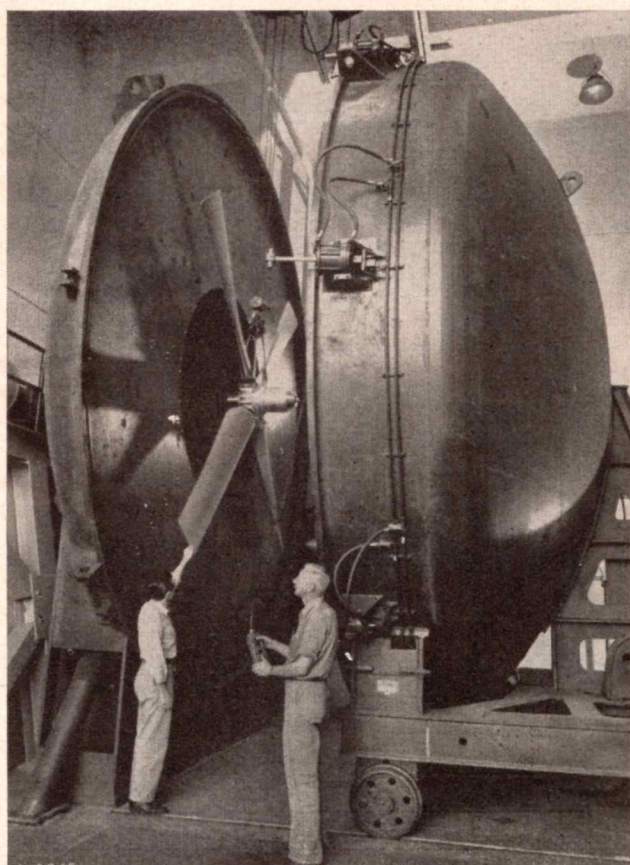
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Clamshell Prop Testing

By GEORGE McLAUGHLIN

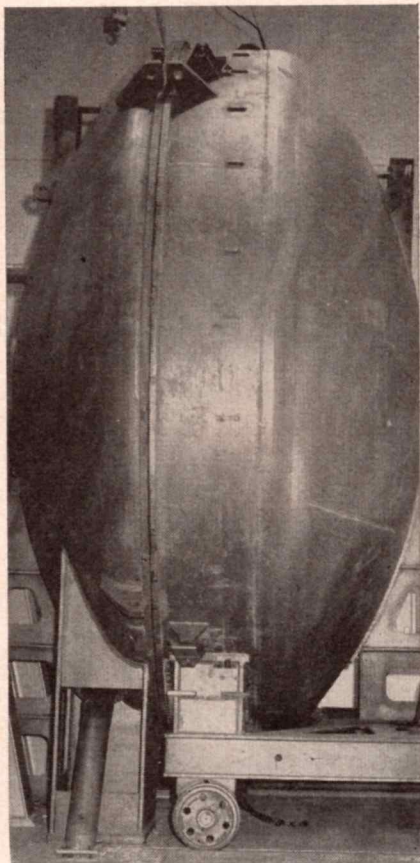
LATEST method of measuring and analyzing mass dynamic unbalance of propellers at actual flight blade angles is with a specially designed steel "clamshell," near-vacuum test chamber. Installed by Hamilton Standard Division, United Aircraft, in a recently completed experimental engineering test building at the Windsor Locks (Conn.) plant, the chamber is scheduled to be put in operation this summer.

The 30-foot chamber will accommodate propellers up to 20 feet in diameter, the largest anticipated to be required for the near future.

One side of the shell through which the propeller shaft enters is supported upright in a fixed position, the electric motor for pro-

propeller operation supported on a bridge structure behind it.

The movable section of the shell is carried upright on a steel framework structure on a truck with wheels resting on floor tracks. The halves of the shell are separated to allow access for installing the propeller to be tested, and an electric hoist on an overhead rail is brought into play to support the propeller while it is being positioned during installation on the propeller shaft. The truck, driven by a motor geared to the rear axle,

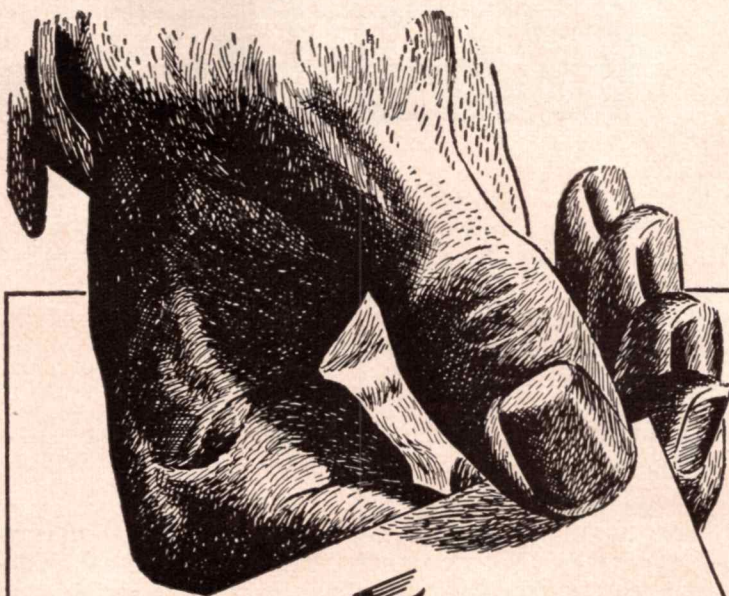


Atmosphere in the chamber can be simulated from sea level to 100,000 ft. in 15 seconds

brings the mating halves of the shell together against a rubber gasket along the rim of the shell. Six hydraulically-operated clamps draw the halves tightly together to seal the chamber.

A bank of three rotary pumps, having a total of 900 hp, is used to evacuate the air from the chamber to the required simulated altitude. Atmosphere in the chamber can be reduced from sea level to a simulated altitude of 100,000 ft. in only 15 secs; the pumps can handle 70 lb. of air per minute at a simulated altitude of 60,000 ft. The propeller may be run at speeds up to 1000 rpm.

END



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New concepts of flight for the jet era... as well as engineering advances on the world-renowned C-119 Flying Boxcar and soon-to-be-produced C-123 Assault Transport are coming from Fairchild. Diversified, stimulating assignments like these increase the inventive challenge to Fairchild's team of qualified aerodynamicists.

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You'll be investing wisely in a secure future if you take time today to write to Walter Tydon, Chief Engineer, outlining your qualifications. Your correspondence will be kept in strict confidence, of course.



ENGINE AND AIRPLANE CORPORATION
FAIRCHILD
Aircraft Division
HAGERSTOWN, MARYLAND

PLANES AT WORK

Press, radio and TV recently turned out in large numbers to see a Bell helicopter with Flight Test Pilot Bill Gallagher at the controls land in a Buffalo shopping center to pick up \$87,075 in U. S. Savings Bonds purchased by Bell employees.

Flying a four-place 150-hp Belanca, two Santa Monica Division Douglas engineers, Walt Rosnow and Ken Kiser, vacationed last summer with an 18,000-mile tour of South America, where bad weather forced them down repeatedly—once on a back road in San Salvador, where they were mistaken for smugglers.

Although it was officially delivered Aug. 31, the Air Force VC-121E *Constellation* actually went to work in September—for President Eisenhower.

Sikorsky S-55's are scheduled to fly ten round-trips daily between Malmo, Sweden, and Copenhagen, Denmark, beginning next July 1. Flying time between the two cities will be 15 minutes. A taxi service in the same area is also planned with Bell 47's.

Word has it that the British Overseas Airways Corp. is ready to place an initial order—subject to approval by the British govern-

ment—for 10 Douglas DC-7B aircraft powered by Rolls-Royce RB109 turboprop engines. Delivery: 1959.

First overseas purchase of the DC-7B has been made by South African Airways. Costing \$8.4-million, the three aircraft will be used between Johannesburg and principal European cities.

Lockheed *Neptune* anti-sub planes will soon be fitted to fly with new jet engines augmenting regular turbo-compound engines, in accordance with a \$9-million modification contract received by Lockheed. All model P2V-5 and P2V-6 twin-engine *Neptunes* will be returned to the factory where they will be equipped like the P2V-7 (see photo) now coming off production lines.

Air Force has taken delivery of the first two production models of the Fairchild C-123B *Avitruc* for further testing.

The famed Lockheed F-80 *Shooting Star* which became the first U.S. operational jet fighter to set a world's speed record (623.8 mph on June 19, 1947) will be preserved in the Air Force Technical Museum at Dayton.

A new record for engines on

Convair B-36's was set recently by the Seventh Bomb Wing at Carswell AFB. When four engines were pulled—still operating efficiently—they had put in 820 hr. 35 min. without overhaul or major repair. During the 31 months between overhauls, 15 different AF crews had been on the plane.

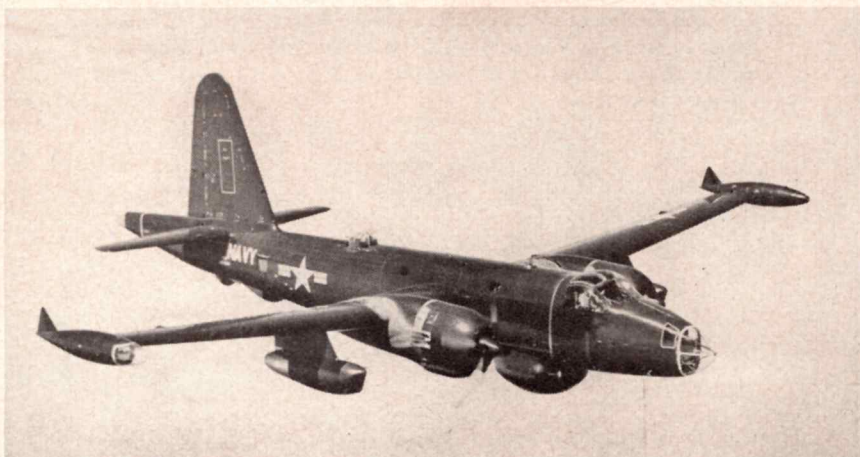
B-26's now being flown by the 345th Bomb Sqd. at Langley AFB, Va., are soon to be replaced by Martin B-57B's.

First of an undisclosed number of Boeing B-47B's have been returned to Boeing's Wichita plant for up-to-date modification. The entire program will be an 18-month job, involving 3000 employees. So many advancements have been made since the first B-47B flew in April 1951, that about 160 kits will be added to each plane, plus six major modernizations.

Martin P5M-2 *Marlins*, first of the Navy's new anti-sub planes, are going into fleet operation with patrol squadron VP-47 at Alameda, Calif. In addition to the new "T" tail for better control during slow airspeeds and water maneuvers, the P5M-2 features a long, slender bow line which permits take-offs in heavier seas at higher gross weights than were previously possible.

The OE-2, an improved version of the Cessna L-19, made its first flight at the Cessna plant. Ordered by the Marine Corps for observation and reconnaissance, the OE-2 has a top speed of over 180 mph, can carry a 250-lb. bomb on each wing, three rockets, a telephone wire-laying container, a chemical spray tank for laying smoke screens, or an aerial delivery container for dropping supplies to ground troops. The Cessna-designed para-lift wing flaps give the

First flight view of Lockheed P2V-7 *Neptune* reveals two pod-mounted jet engines supplementing its turbo-compounds



plane short take-off and excellent slow-flight characteristics.

It's fun to get thoroughly drenched—when the fluid is champagne. Mrs. Earl Warren, wife of the Chief Justice, christened United Air Lines' inaugural Washington-Chicago-San Francisco DC-7 with gusto and good spirits.



Mrs. Warren takes a champagne wetting

Ten minutes after accepting delivery of the Tactical Air Command's first F-100 at North American's Los Angeles plant, Col. Maurice G. Long flashed across George AFB 75 miles away. "I barely retracted my gear before it was time to let down," he commented. The 479th Fighter Wing at George will be the first operational unit to be equipped with the F-100.

Navy Grumman F9F-4 Panthers and F9F-7 Cougars, grounded so that fuel nozzle support brackets in the Allison J-33-A turbojets could be replaced, are being reactivated at a fast clip.

A plush conversion of a new Convair 340 has just been completed by TEMCO—and it's a job fit for a king. An executive office, a roomette with sleeping accommodations, lavatory and shower and seats for 20 passengers are all richly furnished—including an hydraulically-operated disappearing coffee table. The man who will sink his feet into the thick carpeting—Abdul Aziz Ib u Abdul-Rahman Al-Feisal Al-Sáud, King of Saudi Arabia.

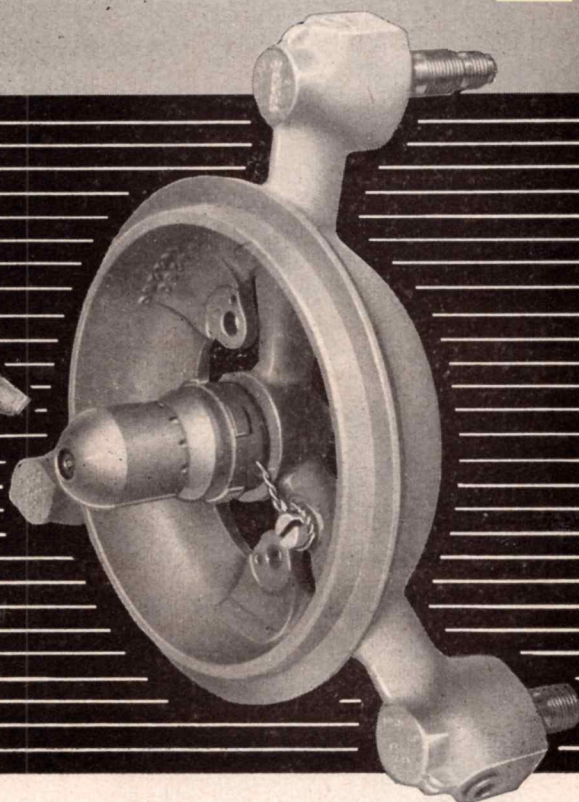
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Nozzles for JETS

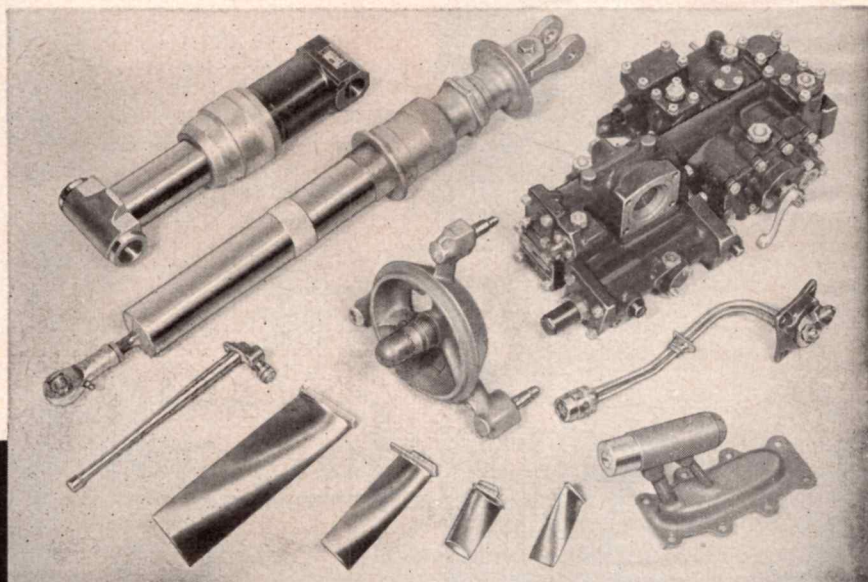
THIS IS ONE

of many Stainless Steel nozzle assemblies for jet engines built by Ex-Cell-O Corporation, one of the world's largest producers of aircraft precision parts.



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Marlins Abroad

Following extensive testing, the Navy announces that P5M Martin *Marlins* are fit and able for combat duty in European waters if needed.

Tests consisted of 55-day patrol flying this summer over Mediterranean areas west of Italy. Twelve P5M's of patrol squadron VP-44 from Norfolk, Va., participated. The twin-engine, anti-submarine planes were flown to Europe on the Great Circle Route to Pembroke Dock, Wales, and thence to Taranto Bay, Italy, main base for operations. Supplies and maintenance were handled by Seaplane Tender USS Currituck.

Waiting for Hazel

Hurricane Hazel almost made impossible the unofficial helicopter altitude record of 24,500 ft. set Sunday, Oct. 17 by Sikorsky's XH-39 at Bridgeport, Conn.

Set for the preceding Friday, the try was stopped cold by the big wind, and Saturday found the neighborhood in such a state of confusion and winds still so high that a second postponement was ordered.

Even on Sunday, when lower altitudes calmed, the helicopter ran into winds as high as 150 mph before reaching the record.

Previous record was set in a Piasecki H-21 on Sept. 2, 1953, at Dayton, O.

World 'Copter Program

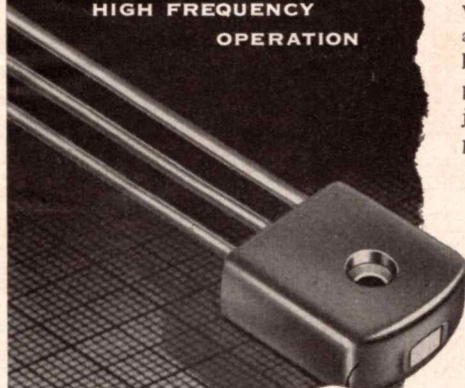
Forerunner of the day when helicopters will be used throughout the world, a committee of operators will hold its first meeting at Montreal in November under the auspices of the International Air Transport Association. Meeting will run from Nov. 11 through 13.

The IATA Helicopter Working Group will include experts from airlines and local air services on three continents who have already begun operations, as well as representatives of companies who soon plan to go into action.

The group will concentrate on different rules needed to govern helicopter service as contrasted with fixed-wing planes in connection with air traffic control, communications, weather, personnel licensing, and navigation.

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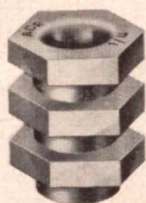
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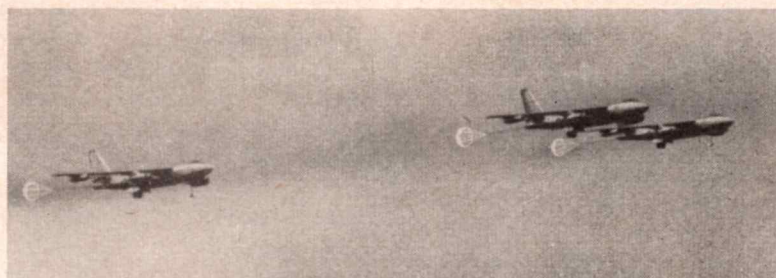


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Novel parachute rig on Boeing
B-47's used for landing approaches

New Chute Steepens Descent

THIS is the first photograph of
the new "approach 'chutes" in
use on three B-47s built for the
United States Air Force at the
Lockheed Aircraft Corporation op-
erated Government Aircraft Plant
at Marietta, Ga., 10 miles north of

Atlanta. The approach chute is in
addition to the 32-foot diameter
landing deceleration (drag) chute
which has been used on the
Boeing-designed B-47s for braking
purposes for six years.

The approach chute is 16 ft. in

diameter and is deployed in the
air for greater control while mak-
ing approach runs for landings.
The chute permits the bomber to
make a steeper landing descent. It
was developed by the Air Research
and Development Command. The
approach chute is standard equip-
ment on new B-47s and gives the
big bomber the appearance of a
jet-propelled "stork."

END

Bell Announces New Passenger Model

BELL Aircraft Corporation's newest three-place production helicopter will be ready for the market shortly after the first of next year.

The new model, the 47H, is a streamlined version of Bell's three-place utility helicopter which has accumulated more than a million

hours of flight experience. Similar in general appearance to the recently-announced four-place 47G-1, design of the 47H has many specific details recommended by commercial and military operators contacted during extensive market survey tours with the Model 47G.

Joe Mashman, assistant director

of contracts who conducted the surveys, said that a number of commercial operators emphasized a need for increased cruise speed in addition to greater pilot and passenger comfort provisions.

"These needs are taken care of in the new craft," Mashman said. "By streamlining the basic Model 47G, our speed is increased about 20 percent and a proportionate reduction in fuel consumption is accomplished. A metal monocoque tail boom contains a baggage compartment large enough to carry luggage for all occupants.

"We have enlarged the custom-designed cabin interior to 60 in. in width. This permits the use of automobile size seats for passengers and pilot, and we have reduced cabin noise-level to a point where conversation can be conducted at normal voice ranges."

In addition to boost controls for greater handling ease, all electrical switches and carburetor controls are grouped in a console located at the pilot's left and away from the passengers. This permits left-hand operation of the console controls without removing the right hand from the cyclic control stick at any time.

Floyd Carlson, Bell's chief helicopter test pilot, says that the new arrangement has proved to be both practical and convenient. Carlson is conducting flight tests for C.A.A. certification.

The 47H will be powered with an improved version of the Franklin 200 hp. engine. Bell engineers predict a marked reduction in maintenance for the new engine which will operate at lower percentages of power for equivalent cruise speeds due to the Model 47H's streamlining. Use of removable cowling makes the engine readily accessible.

Other innovations in the 47H design include the use of fibre-glass construction for some cabin and door assemblies. This material, although lighter in weight than sheet metal, possesses higher tensile strength and rigidity characteristics and requires less maintenance.

From preliminary flight studies, operating costs per seat mile will be considerably lower for the Model 47H than for comparable craft. Although this model is intended primarily for the executive



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transport and passenger market, it is designed to accommodate most utility kit installations and float gear for amphibious operations.

As in its predecessor, time between major overhaul will be 600 hours.

G-E Height-Finder

A radar height-finder that can withstand hurricane winds is the latest General Electric Company contribution to the nation's electronic defenses. Developed in cooperation with the Air Force Air Research and Development command, the new set can detect planes almost three times as far away as former matching units. Teamed with search radar, it will detect high-flying aircraft and provide information on distance, altitude and direction. It will be built in mobile and fixed models. A radome of woven glass fabric impregnated with a rubber compound is used to protect radar antenna in Arctic climates from gales, snow, and ice. This can withstand winds up to 125 mph.

Boeing 707 Notes

Boeing Airplane Company is convinced that its new 707 jet transport will meet airline requirements and will usher in a new era of air transportation for the military and the airlines according to Kenneth C. Gordon, Boeing manager of commercial sales.

Speaking on the design aspects of the 707, Gordon says that it was found that the commercial configuration requirements could be accommodated without penalties for the military, adding that the ability to correlate the military and commercial requirements in a single design was one of the principal reasons Boeing's "\$15-million gamble" was undertaken.

"We found we could match the longest non-stop ranges being operated today with sufficient payload to meet our DC-6B target economics in terms of cost per seat mile," Gordon said in reviewing major design decisions that were made. "The 550-miles-per-hour cruising speed coupled with the high payload provides a work capacity of three to four times cur-



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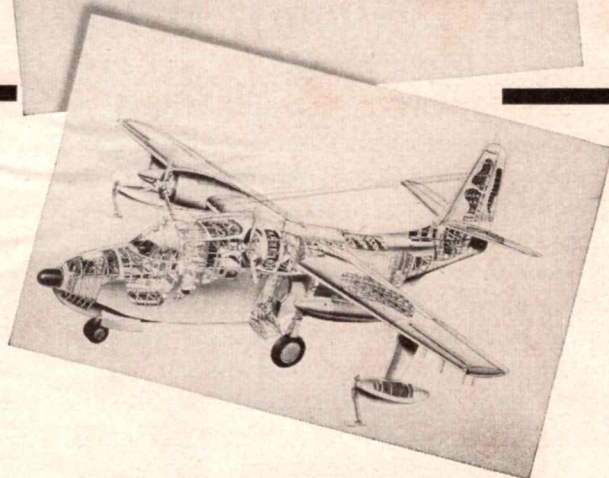
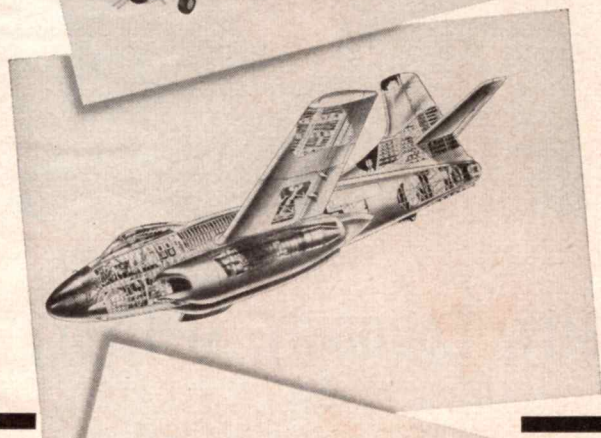
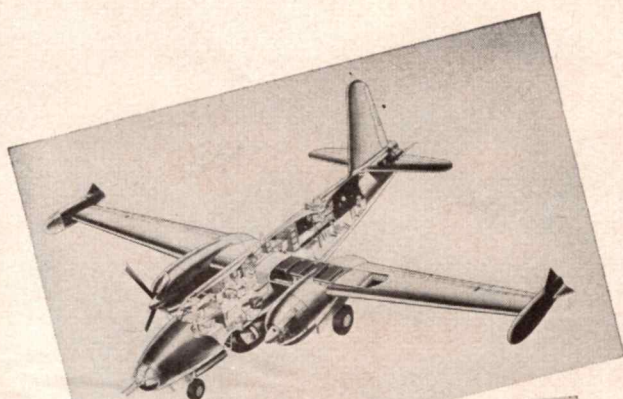
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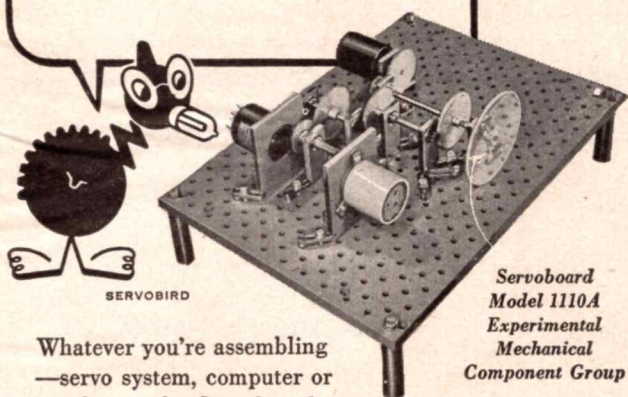
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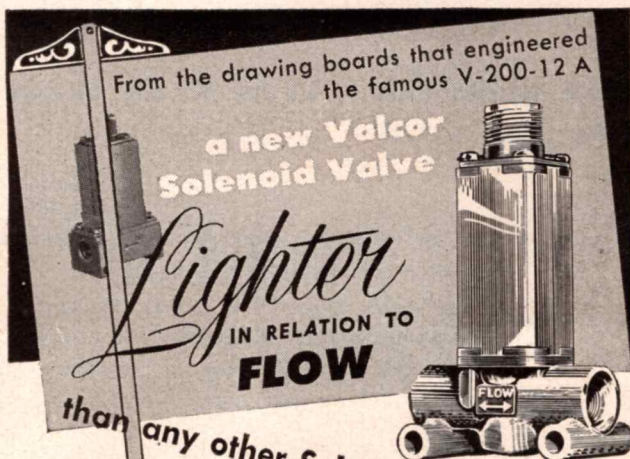
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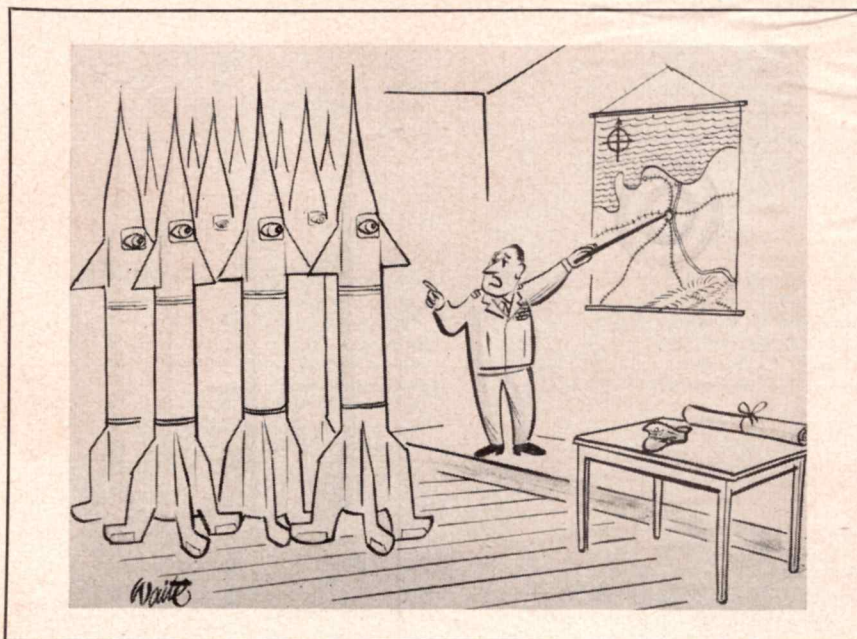
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Gordon said that one of the most significant accomplishments resulting from multi-jet experience lies in the development of the control systems incorporated in the 707. The B-47, Boeing's first swept-wing multi-jet airplane, used a fully boosted control system for all three axes, but extensive flight testing coupled with much research and wind tunnel testing led to the elimination of boosts from the control surfaces for later designs. Spoilers are also used for use as

supplementary lateral control devices, as air brakes for rapid descents, and as air brakes to unload lift from the wings during the landing run.

Fuselage, airplane systems and

empennage of the 707 are of conventional design. Integral fuel tanks rather than the bladder cells are used which is one notable departure from usual Boeing practice.



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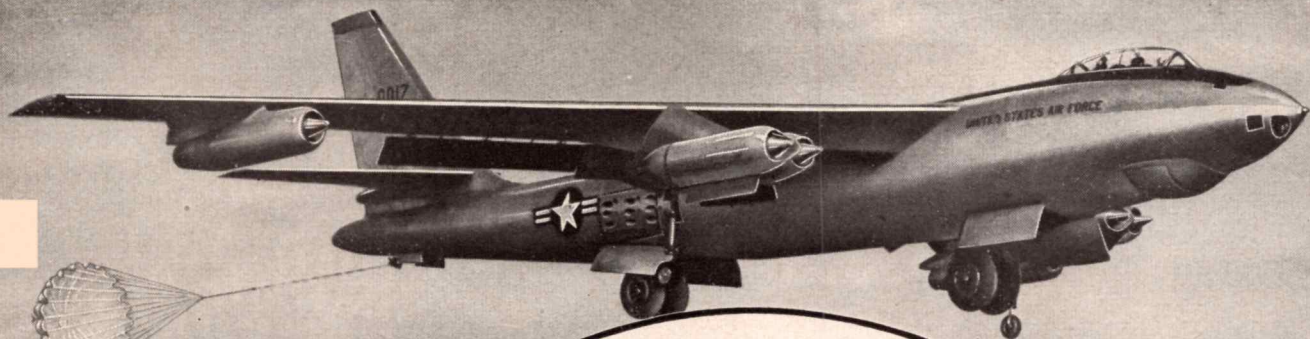
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STOP ON TIME

The B-47 Jet Bomber is built to GO and go it does with a speed that challenges the imagination (London, England to Limestone, Maine in 4 hours and 43 minutes) even in this day of supersonic speeds by smaller planes. But when it's time to come down, landing and stopping this 6-jet aircraft must be done with both accuracy and dependability. To accomplish this, Boeing Airplane Company uses Pioneer specially-built deceleration 'chutes to approach the runway and larger ribbon 'chutes to shorten the landing roll — a maneuver that has won the praise of the aviation industry — of which Pioneer is proud to be an integral part.

PARACHUTES MAKE THE DIFFERENCE!

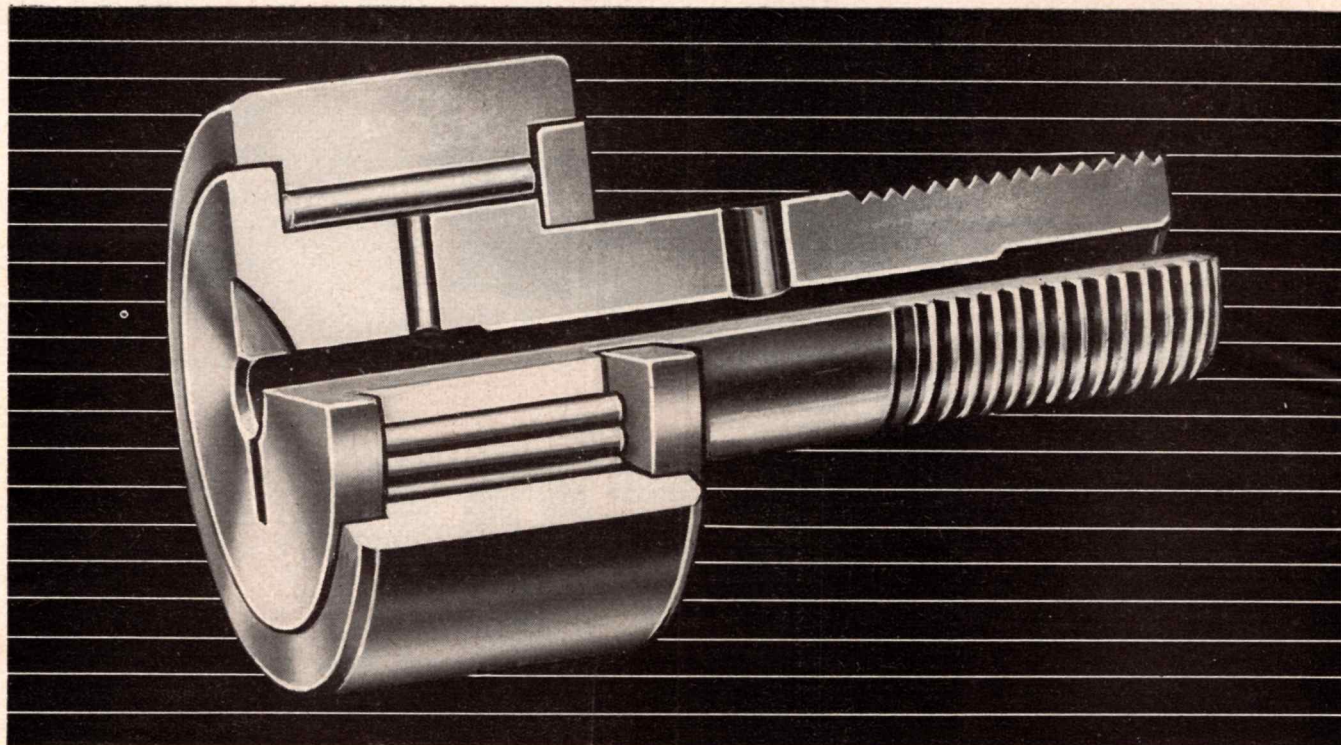


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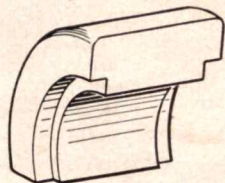
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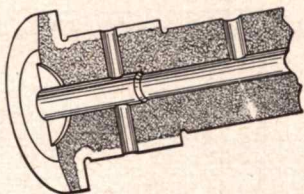
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Give Longer Service... Carry High Shock Loads

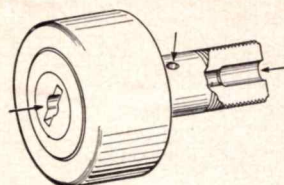


1. Heavy sectioned outer race of hardened and ground high carbon chrome steel assures uniform distribution of high rolling and shock loads while providing high capacity anti-friction performance.

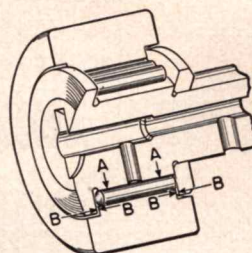
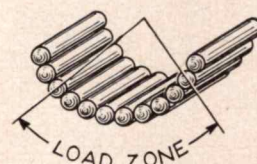
2. Integral stud for cantilever mounting is made of case hardened and ground low carbon nickel molybdenum steel. The tough core provides high strength to withstand high shock loads.



3. Easily relubricated at any one of three points—at either end or through cross hole in stud. Ends accommodate standard drive grease fittings, or may be sealed by the plugs provided.



4. Full complement of small diameter rollers—through-hardened, ground and lapped—for maximum radial load capacity.



5. Raceways precision ground for even load distribution (A) and uniform low end play (B) assure long bearing life.

Torrington Cam Followers are precision made throughout. They are available in sizes from $\frac{1}{2}$ " to $2\frac{1}{4}$ " O.D. Special surface finishes such as chrome and cadmium plate or oxide black can be provided.

Our Engineering Department will be glad to work with you in adapting these dependable and efficient Cam Followers to your cam-controlled or track-type equipment. Torrington Cam Followers give better service because they're better made.

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